Smith

U. S. DEPARTMENT OF AGRICULTURE.

SOME PRACTICAL SUGGESTIONS FOR THE SUPPRESSION AND PREVENTION OF BOVINE TUBERCULOSIS.

BY

THEOBALD SMITH, M. D.,

Chief of the Division of Animal Pathology, Bureau of Animal Industry.

[Reprinted from the Yearbook of the U. S. Department of Agriculture for 1894.]

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Chief of the Division of Animal Pathology, Bureau of Animal Industry, U. S. Department of Agriculture.

Tuberculosis among domesticated animals, more particularly among cattle, has during the past few years received a large share of attention, mainly because of its possible direct influence on human health. With this idea in the foreground, the bearing of this malady on agricultural interests has been more or less obscured. As a result we have a great mass of publications on the hygienic aspect of tuberculosis and but very little on the prevention of this disease among cattle. Many of the more valuable contributions to our knowledge have been made in order to show more definitely what degree of tuberculosis makes an animal unfit for food. This point of view, while bringing out now and then valuable facts, does not pay sufficient attention to the animal during life. What to do to reduce the high percentage of infection among living animals has been practically ignored in all but a few recent publications. It became evident to the writer some years ago that this was, after all, the most important aspect of the serious problem of bovine tuberculosis. If the disease can be restricted and repressed among cattle during life, the hygienic problem will take care of itself.

To attack tuberculosis as it exists at present is undoubtedly a most difficult problem, and the conditions which tend to repress or to augment its further dissemination are very complex. No single measure, however sweeping, is likely to be successful. A number of details will have to receive careful attention, and in the end the success will depend largely upon the intelligent watchfulness constantly exercised in various directions by the stock owner. The wide dissemination and the localized intensity of this disease, especially in herds devoted to breeding purposes, will require, above all, concerted action in attempts for its repression.

Though a strictly bacterial disease and introduced into the body only by the tubercle bacillus, which is always derived from some preexisting case of disease, tuberculosis differs, nevertheless, from most animal diseases in very important particulars. Its unknown beginnings in the body and its insidious march after it has once gained a foothold are responsible for the existence of a large number of tuberculous animals in all stages of the disease. In the earlier stages, while the disease is

still restricted to a single focus, the animal is to all outward appearances in perfect health. It is only after the infection has invaded several cavities of the body or produced mechanical obstructions that it becomes manifest. The prolonged latency of the first stage of the disease, with little or no discharge of tubercle bacilli, raises the question, What should be done with such cases? A comparison with some other infectious diseases makes the predicament all the clearer.

When an animal becomes infected with anthrax or with Texas fever, the specific microorganisms begin to multiply at once within the body. Within twenty-four hours in the case of anthrax, and a few days to a week in Texas fever, the symptoms are fully developed, and death or recovery speedily follows. There can be no question here concerning degree of disease or utility of the animal during the earlier stages. The infected and the noninfected are divided by sharp unmistakable barriers. In tuberculosis, on the other hand, the infected animal is practically well during the earlier stages of the disease, and the disease may become stationary, possibly healed. This peculiarity of tuberculosis modifies to a certain extent the usual measures employed to repress an infectious disease. In certain diseases the necessity for the destruction of all infected animals becomes imperative, because the disease must be kept restricted and suppressed as soon as possible. The present wide dissemination of this disease and its prevalence among other domesticated animals, such as dogs, cats, horses, goats, and above all, its prevalence in man, makes the complete extinction of this malady an unrealizable problem, or at most one whose ultimate success can not be positively predicted.

It is largely due to these peculiarities that tuberculosis has received so little attention until recent years. Its unrecognizable beginnings and slow, insidious march in the body made it appear on the surface as a disease not of infectious origin, but as one in which inheritance played an important part. After the discovery of the true cause in the form of a bacterium (*Bacillus tuberculosis*) by Koch the conception that infection played the most important rôle has gradually gained a firm foothold. Without in any way wishing to eliminate the factor of heredity, the writer has based the statements in the following pages entirely on the principle, now universally recognized, that without the presence of the tubercle bacillus there can be no tuberculosis. If it can be shown that the tubercle bacillus can be kept away from cattle by adopting precautionary measures the discussion concerning heredity would be useless. If, however, this should prove to be impossible, the problems of breed, heredity, and environment, or, in other words, the accessory causes, will require renewed study.

The conditions peculiar to this disease which confront the agricultural interests may be summarized under the following heads:

(1) The present wide dissemination of the disease, no territory being absolutely free from it.

(2) The large percentage of infected cattle which are in the earlier stages of the disease, or in which the lesions are insignificant, stationary, or healed.

(3) The absence of any disturbances of health for considerable periods of time after infection.

(4) The possible transmission of tubercle bacilli from animals to man, more particularly in the milk.

CHARACTER OF THE DISEASE.

Tuberculosis in cattle is at the outset a strictly local disease. Though the entire body has been, to a certain extent, influenced by the local changes, as shown by its sensitiveness to tuberculin, the tubercle bacilli themselves are restricted to that locality where the disease process shows itself to the naked eye. Where the infection has been very severe, that is to say, where there are large numbers of tuberculous cattle in a herd which are continually discharging the virus (in the manner indicated below), so that the remaining animals are being exposed to large numbers of tubercle bacilli, the disease may start in several places within the body at the same time, and its subsequent progress may be, on this account, somewhat more rapid.

In the majority of animals, however, that are killed in the early stages of tuberculosis the disease process is limited to a single spot for a time. The location of this spot will vary with the manner of infection, and possibly with other conditions not yet definitely known. In most cases the tubercle bacilli settle down at the start in some lymphatic gland and there begin to multiply. This multiplication is accompanied by an enlargement of the gland. The size attained by diseased glands varies in accordance with the number of bacilli which have settled down in them. After a certain length of time the enlargement ceases. The gland may be barely larger than before the infection, or it may have gained enormously in size. The writer has seen glands, normally as large as horse-chestnuts, become as large as a child's head.

When the enlargement has come to an end, further changes begin to take place within the gland. The new tissue produced by the presence of the tubercle bacilli begins to assume a yellowish color and to degenerate slowly into a cheesy mass. Hence, when tuberculous glands are cut open we note in those not very much enlarged yellow masses sprinkled in the gland substance, varying in size from one-sixteenth to one-fourth inch. The coalescence of these gives rise to larger cheesy masses. In those glands which have become very large the appearance of the gland when cut open is somewhat different. The cut surface, at first grayish in color, later on appears permeated with a network of yellowish lines, which network encroaches slowly upon the grayish tissue until the entire substance of the gland has become yellowish in color and tough in consistency. Gritty particles are usually embedded in it. Lastly, it may become entirely calcareous, gritty, mortar-

like,[1] or it may break down into a semifluid mass of a yellowish color, resembling soft cheese in consistency. In this state the enlarged gland is nothing more than a bag filled with this cheesy matter. Every vestige of the original gland structure has disappeared. This description of the disease process and the appearances presented by the changes to the naked eye are characteristic of tuberculosis wherever it may appear. The same cheesy breaking down occurs in the lungs, the liver, the bones, and other affected parts.

Thus far the disease may have been entirely restricted to the gland or system of glands in some one part of the body. The process may have lasted a year or longer. When the softening takes place, the disease may become stationary, or, what is perhaps more likely to happen, blood vessels in the gland may become broken down and the tubercle bacilli in the softened mass carried in the blood to other parts of the body. This is usually the time when the infected cow will begin to show outward signs of disease and when the milk may carry tubercle bacilli. Bacilli may be carried in the blood to the uterus and there they may set up tuberculosis, and, in case of present or future pregnancy, infect the unborn calf.

The outcome of the disease may be neither in cure nor in a general infection of the body. It may take a middle course. It may slowly creep from gland to gland. The lining membrane of the chest and the abdomen may become studded with peculiar masses of tubercles which crowd upon the vital organs and interfere with their movements. The animal may become emaciated and lose strength in spite of the best care and food, because of the large amount of tuberculous material lodged in the body. The sometimes enormously enlarged glands in the chest near the backbone compress the gullet so that gases can not escape from the stomach. The animal has irregular or regular attacks of bloating, or the glands in the back of the throat may become so enlarged that swallowing and breathing are interfered with. Food may pass down the windpipe and cause pneumonia. It has already been stated that the spot which is the first to be diseased depends, among other things, upon the manner of infection. Thus, if tubercle bacilli are taken in with the milk, there is likely to appear in the calf (1) disease of the glands of the throat; (2) disease of the glands in the abdomen, which are situated on the membrane that suspends the intestine (mesenteric glands), because the tubercle bacilli pass into these glands from the food in the intestines; and (3) disease of the liver and its glands, because the blood passing through the liver comes largely from the intestines.

If the tubercle bacilli are carried in a dried state into the body, they may lodge in the nasal passages and start up disease of the throat glands, or, what is more probable, they may pass into the lungs with the current of air. Here they may set up disease in the lung tissue, or they

[1] The conversion of the disease products into calcified masses may be regarded as a healing process. In rare cases the tubercles in the earliest stages become healed.

may pass on into the glands back of the lungs and attached to the windpipe and there first begin their destructive action.

When the bacilli pass from the blood of the mother into the blood of the fetus, they generally lodge in the liver, although they may settle down in other regions of the body at the same time.

Tuberculosis of the lining membrane of the chest and abdomen, to which reference has been made above, has given this affection the name of "pearly disease."

It has already been stated that the uterus and the udder may become the seat of tuberculosis whenever tubercle bacilli are brought to them in the blood from other regions of the body. It is probable that the uterus may be infected from without by the bull, and that the udder may be infected by hands carrying the bacilli. On this latter point the evidence is at present inconclusive.

The progress of tuberculosis in the body is modified by various conditions not yet fully understood. Age seems to have some influence. In very young animals the tendency toward a restriction of the disease by a calcification of the tuberculous masses seems to be greater than at more advanced periods of life. In aged cattle the progress of the disease seems likewise less rapid, but for reasons not yet understood. The influence of sex is not known. It is probable that the disease, other conditions being equal, makes slower progress in bulls than in cows.

The conditions under which the purely local disease becomes generalized by a distribution of the virus in the blood are not yet understood. The sudden breaking down of cows in good health, observed not infrequently, is probably the result of such distribution of the virus. We may at least provisionally assume that any strain upon the cow is likely to hasten the onset of generalized disease. Among these strains the giving birth to calves must be regarded as the greatest. The giving way of some diseased spot at this time favors infection of the blood of the calf at birth. Cows which do not recover after calving, and in which a discharge from the vagina persists after the proper time, not directly traceable to retained afterbirth, should be regarded with suspicion and promptly killed, for in such animals the milk is likely to be infected with tubercle bacilli. It is probable that other strains, such as exhaustive marches, chasing, etc., may lead to the same result.

This brief sketch of the disease is sufficient to make clear (1) the primarily local character of the disease and its usually slow progress within the body from place to place; (2) its predilection, at the start, for the lymphatic glands and the lungs. Putting the places most frequently the seat of the earliest disease first, we have the following order:

(1) Glands of the lungs (dorsal, mediastinal, and bronchial).
(2) The lungs themselves.
(3) The glands of the throat and intestines.
(4) The liver and its glands.

The infection of the other organs, membranes, and structures of the body, excepting perhaps the uterus and the udder in rare cases, is secondary to these. In endeavoring to comprehend the peculiar nature of this disease the reader should furthermore bear in mind that the virus, i. e., the tubercle bacilli, do not live and multiply in the blood. They are simply carried in the blood, in advanced cases, from organ to organ, and speedily fixed in the tissues, where they produce fresh crops of tubercles. In the earlier stages, when single glands only are the seat of the disease, the blood is free from infection. This accounts for the immunity of the milk in these stages. If there were any method of distinguishing these cases the danger incident to the milk supply could be easily removed. In practice, however, no such distinction can be definitely made; hence the suspicion which rests on all milk which comes from infected herds.

Tuberculosis thus differs from other infectious diseases not so much in its nature as in the degree of its activity. It is a disease long drawn out, presenting stages, covering months and years, the duration of which in other more rapid diseases is measured by days.

THE CONTAGIOUSNESS OF THE DISEASE.

This is linked to the tubercle bacillus, for without it tuberculosis can not develop. Hence our knowledge of the transmission of the disease is derived largely from what we know of the life history of the tubercle bacillus within and without the animal body. Tubercle bacilli may pass from diseased animals in the following ways:

(1) In discharges coughed up, in the case of advanced disease of the lungs. When the glands of the throat are diseased, they may, after a time, break down and discharge into the throat. Other glands about the head and neck may discharge directly outward.

(2) In discharges from bowels, in advanced stages.

(3) In discharges from vagina, in case of tuberculosis of the uterus.

(4) In milk, when the udder is tuberculous or the disease generalized.

(5) Tubercle bacilli may pass from the mother to the fetus in case of tuberculosis of the uterus or advanced generalized disease.

Tubercle bacilli may be taken up by cattle in several different ways:

(1) Fully nine-tenths of all diseased animals examined have been infected by inhaling the tubercle bacilli, dried and suspended in the air.[1]

(2) Fully one-half of all diseased animals examined have been infected by taking tubercle bacilli into the body with the food. This implies that both food and air infection are recognizable in the same animal in many cases.

[1] These estimates are of course merely approximate. Not a few animals who have lung disease reinfect themselves by swallowing the mucus coughed up, or by soiling their own food with it.

(3) Animals are infected, though rarely, during copulation. In such cases the disease starts in the uterus and its lymph glands, or in the sexual organs and corresponding lymph glands of the bull.

(4) Perhaps from 1 to 2 per cent of all calves of advanced cases are born infected. Among the 200 cases of tuberculosis, including all ages, which have been examined by the writer, there are about 2 per cent in which the disease is best explained as having been directly transmitted from the mother during or before birth.

We may define the dangers of infection somewhat more definitely by the statement that in any herd, even in those extensively infected, only a small percentage of the diseased animals, namely, those which are in an advanced stage, or such as have the disease localized from the very beginning in the udder, or the uterus, or the lungs, are actively shedding tubercle bacilli. It is these that are doing most, if not all, of the damage by scattering broadcast the virus.

Disease of the udder is particularly dangerous, because the milk at first appears normal for some weeks, and therefore would be used with impunity. Moreover, the tubercle bacilli in the diseased gland tissue are usually numerous.[1]

Similarly, in tuberculosis of the uterus the vaginal discharges may contain many tubercle bacilli. This deposited anywhere may lead to the extensive dissemination of the virus, or it may be carried by the bull to other cows. A diagnosis may be made by the examination of any existing discharge for tubercle bacilli.

The foregoing statements apply to individual herds only. To what extent does the danger extend beyond the diseased herd to others in the neighborhood? To this we may give the general answer that there is no danger unless the animals mingle on the pasture or in the stable. Tubercle bacilli are not carried in the open air, or if they are their numbers are so small that the danger of infection is practically absent.

It is also highly doubtful whether they are ever carried in sufficient numbers by third parties from place to place to become in any sense a danger. The reasons for this must be sought for in the tubercle bacillus itself. The diseased animal is the only manufacturer of tubercle bacilli, as well as the chief disseminator. Tubercle bacilli, after having left the body of the cow (and usually in small numbers), do not increase in nature, but suffer a steady decrease and final extermination in four to six months at the longest. Only after they have entered the bodies of susceptible animals do they again begin to multiply. Hence, with this disease the only danger to other herds lies in direct association, or in the transfer of a diseased animal or of milk from such an animal. The great danger exists in the immediate surroundings of the infected, and loses itself as the distance increases.

[1] This fact, mentioned by Bang, the writer has had opportunity to confirm in case of two tuberculous udders examined recently.

PREVENTIVE MEASURES.

The suggestions to be recommended are not to be considered as taking the place of any more sweeping and radical measures which have been contemplated by some States and are actually being tried in others. We wish them to be considered simply as of educational value to the owners of cattle in their efforts to repress and stamp out the disease. The aid of the Government in this matter is a question to be discussed by itself. Without individual cooperation and sacrifice, directed by an intelligent understanding of the disease in its various aspects, any efforts on the part of the Government are likely to prove abortive, owing to the enormous interests involved.

Removal of diseased animals.—This is the essential requirement in the suppression of tuberculosis. We have already stated that only in the diseased animals the tubercle bacilli multiply. Hence, if these are removed and the stables thoroughly disinfected, so that any germs shed by them are destroyed, we are safe in concluding that the disease has been suppressed.

The disease in the early stages can be detected only with the aid of tuberculin. In the advanced stages most careful observers will probably recognize it, or at least suspect it, without the use of tuberculin. Tuberculin, therefore, has become indispensable in giving the owner an idea of the inroads the disease is making in his herd, and in distinguishing the infected from the noninfected. Tuberculin reveals to us all stages, from the earliest, most insignificant changes, when the animal is outwardly entirely well, to the gravest and most dangerous types of the disease. Tuberculin does not, as a rule, discriminate between these cases. Hence those who use it as a guide must not be disappointed when, after having killed the suspected ones, they find that many are in the earlier stages of the malady. Tuberculin, moreover, is not infallible. A small percentage of cases of disease are not revealed by it. On the other hand, a sound animal now and then gives the reaction for tuberculosis. These lapses must be borne in mind in using tuberculin. In spite of them, however, tuberculin must be considered as of great value in revealing tuberculosis not recognizable by any other means during life.

The question next arises, What shall be done with the infected animals? This question is really composed of two distinct questions whose combination is mainly the cause of the present perplexity. From the standpoint of the agriculturist alone the matter is simple enough. The infected animals might be separated at once from the noninfected. The worst cases should be killed and buried deeply or burned. Those without outward signs of disease might be fattened for the butcher and inspected at the abattoir. This is the recommendation given by Nocard, a prominent French authority, and generally followed in European countries. But at this point public health ap-

pears and demands the prompt and complete destruction of all infected animals, however mild the disease, or, if the animal be not destroyed, the rejection of the milk of all infected animals. The interest of the stock owner and of public health are thus diametrically opposed. If the demands of public health were in every sense justifiable from a strictly scientific standpoint, there could be no question as to an entire submission to its demands. But the case is not so simple, and gives room for diversity of opinion. Leaving the public-health aspect of the question aside for the moment, let us return to the farmers' side of it. After all infected animals have been segregated or killed, as the case may be, and the stables disinfected, the remaining healthy animals should be retested with tuberculin within a certain period of time, from three to six months after the first test, to make sure that no disease has been overlooked. Future repetitions must be recommended, according to our present knowledge, for some cases may have been missed by the tuberculin, or the disease germs may possibly be reintroduced by tuberculous human beings, or by tuberculous cats, dogs, and other domesticated animals.

All animals introduced into a herd must have been tested and found to be sound beforehand. This is such a self-evident proposition that it needs no comment.

In the absence of the tuberculin test, or of organized official inspection, the stock owner should carefully and promptly remove from his herd and have destroyed—

(1) All animals which show emaciation, with coughing, and any suspicious discharges from the nose.[1]

(2) Those animals with enlarged, prominent glands about the head (in front of the ears, under and behind the lower jaw), or enlarged glands in front of the shoulder, in the flank, and behind the udder, and all animals having swellings on any part of the body which discharge a yellowish matter and refuse to heal.

(3) Animals with suspected tuberculosis of uterus and udder.

Disinfection and other preventive measures.—It will probably require more or less time before the use of tuberculin will have become generally established. Hence, preventive measures of a general character must still be kept in view for some time to come. These measures partly suffer shipwreck from the fact that it is difficult without tuberculin to recognize even advanced disease during life. Still much can be done to reduce the amount of infection by following out certain general and specific suggestions which the renewed study of the disease has either originated or else placed on a more substantial basis.

[1] Now and then emaciation is due to other causes, such as the presence of foreign bodies in the chest, disease of the liver and kidneys, chronic broncho-pneumonia, etc. Animals affected with these diseases are of no permanent value, and their destruction is in the end an actual saving, since such maladies are usually incurable.

Perhaps the most important preliminary suggestion to be made is, that the owner of cattle should endeavor to familiarize himself as much as possible with the general nature of tuberculosis, its cause, the ways in which the virus may leave the body of the sick and enter that of the well, and, lastly, the ways in which it spreads within the body. He will, by the acquisition of such fundamental knowledge, lift himself above the plane where quackery and specifics abound, and understand precisely what to expect after the disease has entered his herd, and how to meet the demands of public health. He should, moreover, make himself acquainted with the peculiar appearance of tuberculous growths in the body, and open every animal that dies, so that he may know to what extent his animals are dying of this malady. Wherever possible the services of the skilled veterinarian should be made use of. Sanitary precautions should begin with the removal of diseased and suspected animals, as stated above. This is the most essential requirement, for diseased animals are the only breeding places of the specific virus.

After the removal of these, attention should be paid first of all to the stables. Here, during the long confinement of the winter months, when ventilation is all but suppressed, we may look for the source of most of the inhalation diseases so common in tuberculous cattle. Even when only a few cases of tuberculosis have been found, the stables should be disinfected by removal of all dirt and the subsequent application of disinfectants. Since tubercle bacilli are more resistant than most other disease germs, the strength of the disinfecting solution must not be less than as given. The following substances may be used:

(*a*) Corrosive sublimate (mercuric chloride), 1 ounce in about 8 gallons of water (one-tenth of 1 per cent). The water should be kept in wooden tubs or barrels and the sublimate added to it. The whole must be allowed to stand twenty-four hours, so as to give the sublimate an opportunity to become entirely dissolved. Since this solution is poisonous, it should be kept well covered and guarded. It may be applied with a broom or mop and used freely in all parts of the stable. Since it loses its virtue in proportion to the amount of dirt present, all manure and other dirt should be first removed and the stables well cleaned before applying the disinfectant. After it has been applied, the stable should be kept vacant as long as possible. Before animals are allowed to return, it is best to flush those parts which the animals may reach with their tongues, to remove any remaining poison.

(*b*) Chloride of lime, 5 ounces to a gallon of water (4 per cent). This should be applied in the same way.

(*c*) The following disinfectant is very serviceable. It is not so dangerous as mercuric chloride, but is quite corrosive, and care should be taken to protect the eyes and hands from accidental splashing:

	Gallon.
Crude carbolic acid	½
Crude sulphuric acid	½

These two substances should be mixed in tubs or glass vessels. The sulphuric acid is very slowly added to the carbolic acid. During the mixing a large amount of heat is developed. The disinfecting power of the mixture is heightened if the amount of heat is kept down by placing the tub or glass demijohn containing the carbolic acid in cold water while the sulphuric acid is being added. The resulting mixture is added to water in the ratio of 1 to 20. One gallon of mixed acids will furnish 20 gallons of a strongly disinfectant solution having a slightly milky appearance.

(*d*) Whitewash is not in itself of sufficient strength to destroy tubercle bacilli, but by imprisoning and incrusting them on the walls of stables they are made harmless by prolonged drying. Whitewashing should be preceded by thorough cleaning.

Particular attention should be paid to the sides and ceilings of stables. All dust and cobwebs should be periodically washed down. Those parts coming in contact with the heads of cattle, stanchions, halters, troughs, etc., should be frequently cleansed and disinfected, even when they have not been used by diseased cattle.

The removal of virus from the stables should, furthermore, be promoted by the regular removal of manure and by abundant ventilation. Good air has the effect of diluting infected air, and thereby reducing the chance of inhaling dried, floating tubercle bacilli, or at least of reducing the number inhaled. It likewise improves the vigor of the confined animals, and hence increases the resistance to infection.

Cattle should not be placed so that their heads are close together; each animal should have plenty of room[1] and occupy the same place in the stable at all times. These precautions will prevent the nasal, lung, or vaginal discharges from one animal striking the head or soiling the feed of another. It is true that it is impossible to prevent animals licking each other outside of the stable, but it should be remembered that prevention must begin with the removal of all cases which are suspected of discharging tubercle bacilli. Stables should, furthermore, be carefully protected from the expectorations of human beings affected with tuberculosis of the lungs.

Cattle should be housed as little as possible. The pasture has the effect of greatly reducing the chances of infection by a more or less rapid destruction of the virus, as well as by increasing the vigor of the animals through muscular exertion in fresh air. To what extent animals may pick up the virus on fields it would be difficult to estimate. That it is perfectly possible can not be gainsaid. A tuberculous animal may soil the ground over which it passes, and other animals may take up the virus with the food soon after.

It is not likely that the virus remains alive long enough on the ground to become dried and ready for inhalation. The action of sunlight, the

[1] Each cow should have at least 600 cubic feet of air space.

alternate wetting and drying which goes on in nature, may be looked upon as destructive agents. Even if the tubercle bacilli became speedily dried, the great diluting effect of the open air would reduce to a minimum the chances of inhaling the virus.

Among the other dangers deserving attention is the infection of food and water. Drinking troughs should be so arranged that the surface water is constantly flowing away. Discharges from the nose or mouth left floating on the surface may be drawn in by healthy cattle while drinking. Each person must in such cases use his own judgment and ingenuity to prevent infection, in accordance with the quantity of water at his disposal.

To restrict the dissemination of the disease among young stock the safest plan is to bring skimmed milk and other dairy products to the boiling point before feeding them. If the cows are positively known to be healthy, this may be unnecessary, but where any doubt exists the heating should be resorted to. Such a precaution will, furthermore, reduce scouring among calves, which is probably due in a great measure to bacteria in the food.

In presenting the foregoing suggestions the writer has endeavored to keep in view two conditions: (1) That in which tuberculin is not within reach and only unusual watchfulness can be exercised in separating suspected animals from the healthy, and (2) that in which tuberculin is tried, but with the view that it is not wholly infallible and requires to be seconded with other precautionary measures. If tuberculin is infallible, most of the suggestions made fall to the ground as unnecessary, unless the disease can be readily reintroduced by man or diseased animals of other species, a possibility of wholly unknown dimensions at present.

The study of tuberculosis, though prosecuted for many years, still offers many problems of prevention to solve, especially those which pertain to the conditions underlying predisposition. Is the breed or descent of the animal of much importance, or is it the conditions under which each animal is compelled to live which determine the readiness with which the disease destroys the body? These are vital questions, and their answer must have an important modifying influence on the future success of dairying and stock raising. As we are now entering upon an era of suppression of this disease, it should be borne in mind that radical measures are the best to begin with, and that after the disease has been weeded out of each herd by tuberculin one or more times such herds become, in a sense, an experiment in the prevention of this disease, with the element of contagion presumably completely eliminated. The future will then decide how much is to be feared from the lapses of tuberculin, from sources of the virus outside of the bovine species, and from heredity, breed, and environment as predisposing agents.

BOVINE TUBERCULOSIS IN ITS RELATION TO THE PUBLIC HEALTH.

The dilemma in which the demands of public health have put the owner of cattle, as well as the health officer, has already been stated. The following statements referring to this subject are based upon a careful study of the distribution of the disease in a large number of animals. It needs to be emphasized here that arguments deduced from the superficial examination of a carcass and the simple determination of the presence or absence of tuberculosis are worth lit'le or nothing in attempting to solve the problems presented by the sanitary side. Only a thorough survey of the entire distribution of the tuberculous deposits in animals furnishes us with approximately correct data.

The flesh of those infected cattle in which the disease is restricted to one or two primary foci must be regarded as entirely harmless and of full nutritive value. Even in advanced cases, which should always be rejected, the glands embedded in the muscular tissue are found infected only occasionally.

The condition of the milk in different stages of the disease is a question of much greater importance, and demands the most careful consideration. We may, for convenience and clearness, typify three stages:

(1) In the earlier stages of the disease, provided the udder is normal, the milk is free from tubercle bacilli.

(2) In the more advanced stages, provided the udder is normal, the milk may or may not contain tubercle bacilli. If the disease has become generalized, the indications are that at some time or other tubercle bacilli may pass into the milk. This passage is revealed at the autopsy by disease of the glands of the udder. The indications are that this passage is largely temporary, perhaps lasting only a day before the tubercle bacilli are caught up and filtered out into the lymphatic system. The indications are, furthermore, that comparatively few bacilli passed through the udder. The udder itself does not favor their development there, and the closest inspection fails to reveal any augmenting foci of disease. These statements are based on careful examinations of slaughtered cattle and the thorough testing of milk from advanced cases.[1]

(3) When the udder is affected in any stage of the disease, a most grave condition is presented. Tuberculosis of the udder in most cases comes on in the later stages, when the virus is distributed by the blood from some disintegrated earlier focus of disease. Primary tuberculosis of the udder, that is, infection from without, has not yet been established definitely, and is probably of very rare occurrence. When the disease has started in the udder itself, tubercle bacilli may be discharged in

[1] See Bulletins Nos. 3 and 7 of the Bureau of Animal Industry, United States Department of Agriculture.

the milk in large numbers and for long periods of time. The smaller the herd, in such a case, the more dangerous the entire milk becomes, because of the concentration of the virus.

Udder tuberculosis is thus a most serious danger, the importance of which can not be too strongly urged. Fortunately, it is rare. The writer has encountered among 200 infected animals only one case of udder disease, and 16 others which, according to the post-mortem studies, may have shed at one time or another tubercle bacilli into the milk in small numbers, but which had no recognizable disease of the udder itself. The large percentage of udder tuberculosis reported by several writers lately is incompatible with all former statistics, and indicates either an unprecedented condition in certain localities or else an error in diagnosis. The stock owner, in the absence of proper dairy or other official inspection, is under serious moral responsibilities to remove from his herd those animals in which there is even a suspicion of udder tuberculosis. Any udder which is found to increase slowly in size without any indication of inflammatory processes, recognizable by the presence of heat, pain, and redness, and which becomes very firm without showing at first any alteration in the appearance of the milk, should be regarded as infected, the cow promptly segregated, and the entire milk rejected until a diagnosis can be made by a veterinarian.[1]

In view of the fact that tuberculin does not discriminate between dangerous and harmless cases, the public-health problem as it presents itself in practice is simply this: What shall be done with all the cattle which give the tuberculin reaction, in order that we may catch and destroy the 10 per cent[2] of slightly and temporarily dangerous cases among them, or the 1 per cent[2] of serious cases? Some of the dangerous cases are so far along in the disease that they are easily detected without the aid of tuberculin, but this is by no means true of the majority. The situation certainly demands a most rigid periodical inspection of all animals furnishing milk to consumers, the prompt removal of all suspicious cases, and, above all, a more thorough control of the dairy in the interests of public sanitation.

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[1] The stock owner needs here to be reminded that the feeding of milk from a tuberculous udder to calves and pigs is the most dangerous thing he can do in laying the foundation of lifelong tuberculosis in young animals.

[2] These figures may be too high or too low. The collection of further accurate statistical evidence is needed.

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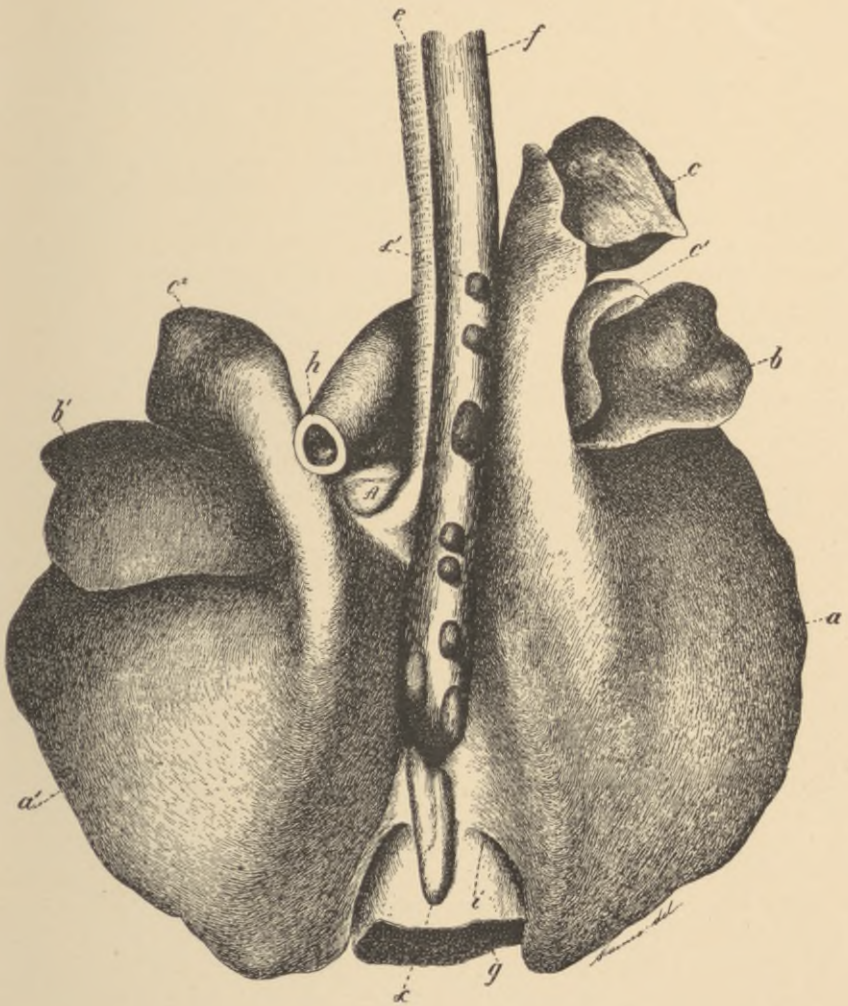

THE LYMPHATIC GLANDS MOST FREQUENTLY THE EARLIEST SEAT OF TUBERCULOSIS IN CATTLE.

a, a^1, caudal lobes; b, b^1, ventral lobes; c, c^1, c^2, cephalic lobes; e, trachea; f, œsophagus; g, muscular pillars of the diaphragm; h, posterior aorta, cut through just beyond the arch and reflected so as to uncover the left bronchial gland A, resting against the root of the left bronchus; i, caudal margin of the ligament of the lungs (*ligamentum latum*).

The glands are represented as small, roundish, and elongated masses, most of them resting loosely on the œsophagus or gullet. The lowest one, marked a, is the most frequently diseased of any gland or organ in the body. When it becomes very large it presses on the gullet and produces bloating.

The gland most frequently affected next to this is marked A. It rests against the windpipe, and the aorta, h, arches over it. Those portions of the lungs adjacent to the gland a are in most cases the seat of the earliest disease within the lung tissue.