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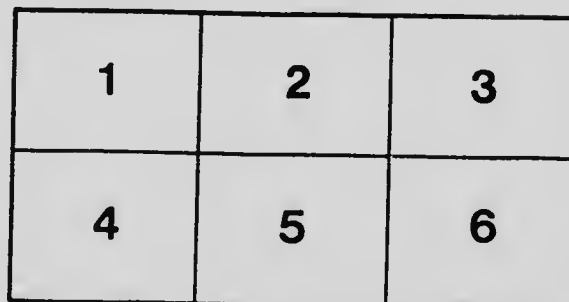
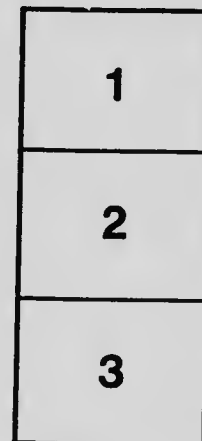
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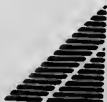
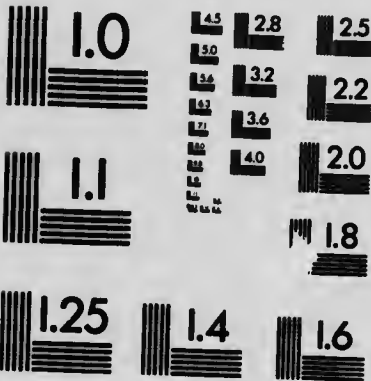
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BULLETIN 193.]

[NOVEMBER 1911]

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Tuberculosis of Fowls

S. F. EDWARDS.

INTRODUCTION.

During the past few years we have received in the bacteriological laboratory a large number of domestic fowls which *post mortem* examination showed were affected with tuberculosis. Although this disease is not new to Ontario, it is annually becoming more widespread among fowls, with consequent serious loss to the poultry industry of the Province and the Dominion. The control of tuberculosis of fowls is therefore a problem of considerable economic importance, and this bulletin is submitted for the purpose of spreading information about the disease and giving suggestions for its control.

EXTENT AND DISTRIBUTION OF AVIAN TUBERCULOSIS.

The first published report of the presence of this disease in Canada was in 1905. Higgins, at Ottawa,¹ in 1904, examined one fowl from Enderby, British Columbia, and one from Renfrew, Ontario. "In both cases the disease was well advanced, being generalized throughout the organs of the abdominal cavity." Previous to this publication, the disease had been identified by Harrison in this laboratory, in specimens received from Dalston and Marysville, Ontario, in August and September, 1903. Since that date there have been examined fowls from forty-seven other points in Ontario. The distribution of the disease in this Province is shown on the accompanying map (Fig. 1).*

In the United States avian tuberculosis was first identified and described by Pernot,² who in 1900 reported upon six outbreaks investigated by him in Oregon during the previous year. In 1903, Mook and Ward³ reported on an investigation of avian tuberculosis in California, where

* The map shows only the places from which tubercular fowls have been sent for examination. The disease is probably much more widespread than the map indicates.

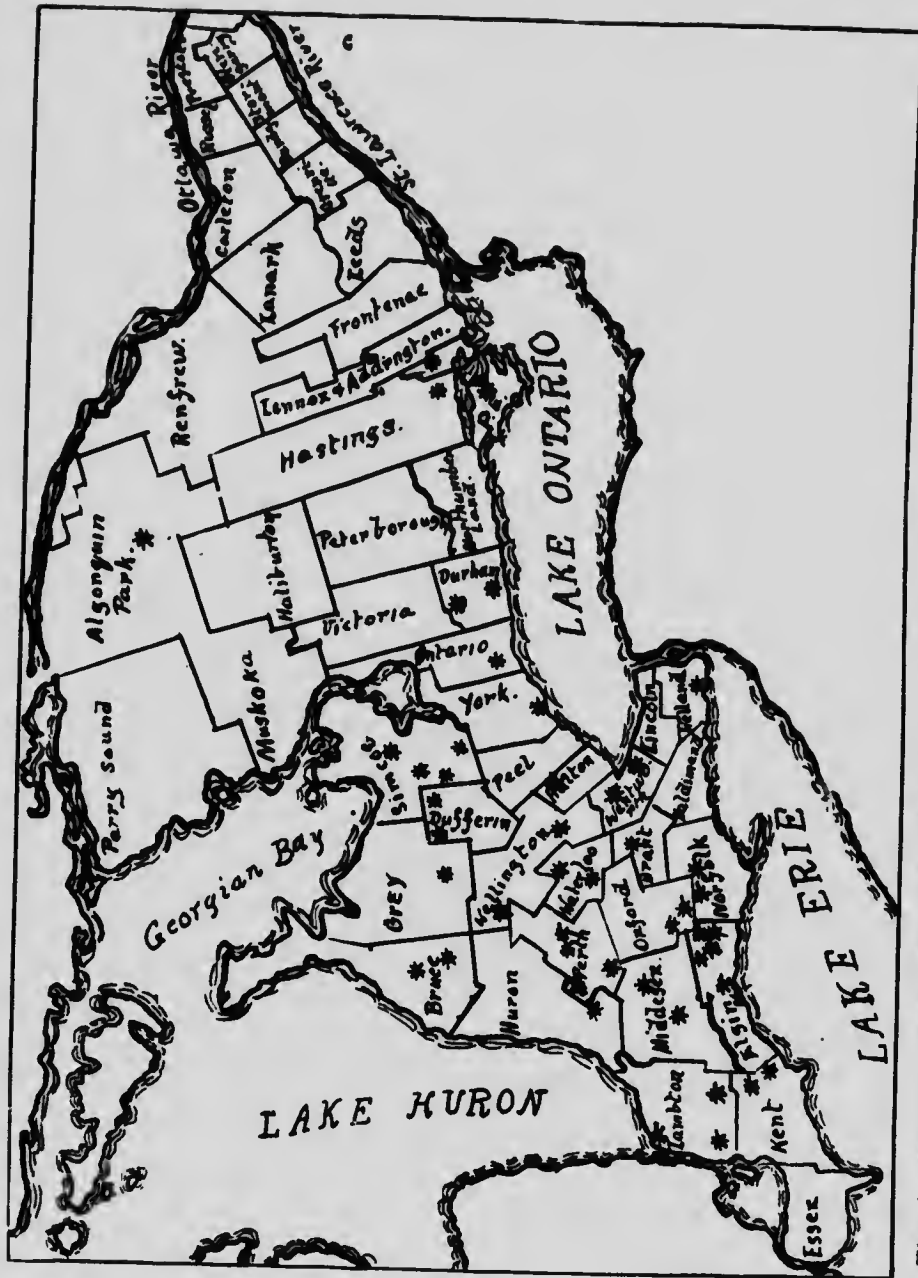


Fig. 1. Map of Ontario, showing places from which tubercular fowls have been sent for examination. The cities or towns are indicated by the stars.

two hundred and fifty fowls of a flock of fourteen hundred had died during the previous year. Burnett⁴ in 1907 reported on an outbreak of tuberculosis among chickens in New York State. Morse⁵ in 1907 reported on cases of the disease in Michigan, and a later report on the disease in that State has just been made by Marshall and Giltner.⁶ Mack⁷ in 1908 reported on three cases of tuberculosis from a small flock of fowls kept in the city of Reno, Nevada, and Beebe⁸ in 1909 reported its presence in Minnesota.

In all these outbreaks the investigators have confirmed their diagnosis by microscopic examination and demonstration of the tubercle bacillus as described later in this bulletin. Several other writers report the finding of fowl tuberculosis in America, though they do not report

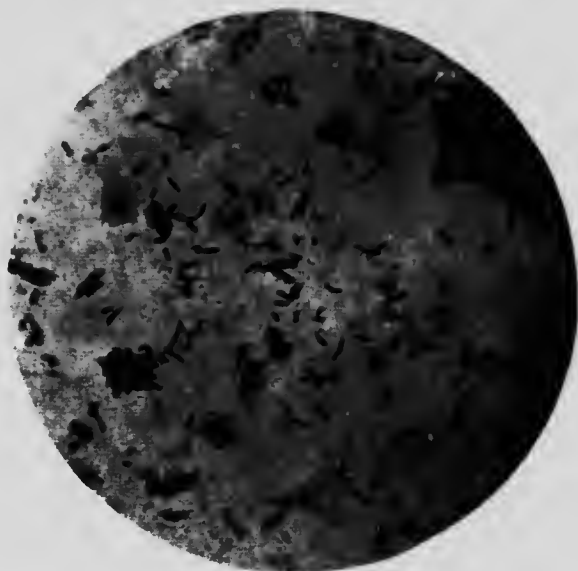


Fig. 2. Tubercle bacilli of tuberculosis from lung tissue of a fowl. Magnified 1,000 diameters.

bacteriological examination. In Europe, the disease has long been known and is reported to be widely distributed.

NATURE OF AVIAN TUBERCULOSIS.

Tuberculosis of fowls is similar in many respects to tuberculosis of man and of cattle and swine. It is a communicable disease caused by a specific bacterial parasite, *Bacillus tuberculosis*. (Figs. 2 and 3.)

The germ is always the direct cause of tuberculosis, and no case can occur unless the germ is carried in some manner from an existing case to a susceptible individual.

Poorly lighted or poorly ventilated houses, insufficient or unwholesome food, errors in breeding, or the presence of mites, may become accessory causes by tending to lower the natural vigor and disease resisting power, thus increasing the susceptibility to attack; but before the disease itself can occur the germ *must* gain a foothold in the body of the bird.

Like tuberculosis of other animals, and of man, the disease in fowls is slow and insidious in its progress. It may exist for some time in a



Fig. 3. *Bacillus tuberculosis* from the liver of a hen. Growth on potato.

flock without detection. Unlike some other contagious diseases, the losses, especially at first, are only occasional, and the farmer ordinarily pays so little attention to the loss of a hen or two that it is not until there are frequent deaths, with more or less regularity, that he attempts to determine the cause of the trouble and the remedy. By this time the disease has gained such a foothold that drastic and sweeping measures must be adopted to eradicate it.

SERIOUSNESS OF THE LOSSES.

While there are no data obtainable as to the exact loss from tuberculosis in fowls, there is ample evidence to show that it is considerable. One farmer wrote us that he lost fifty fowls in seven months. Two others said they had lost a hundred in two years. Others write they lose about one a week. An illustration of how extensive inroads may be made in a flock is shown in the following paragraph from a recent circular from the Michigan Experiment Station.



Fig. 4. Liver of a tubercular fowl in the first stage of the disease. Only a few lesions are present.

"In January, 1911, a large flock of mixed Black Minorcas and Brown Leg-horns was found in L. . . .ston county badly affected with tuberculosis. In the spring of 1910 this flock consisted of nearly three hundred birds. By January, 1911, there were about one hundred and sixty left. A positive diagnosis was made as a result of the examination of a bird sent to this laboratory. An arrangement was made whereby one hundred and forty birds were killed and dressed, and the remainder (those visibly affected) were sent to the laboratory for experimental work. Of the one hundred and forty birds killed forty were found to be tuberculous."

BIRDS AFFECTED.

Tuberculosis of birds is confined mostly to chickens, although other domestic fowls may contract the disease. In this laboratory we have observed it in chickens and turkeys and in a pair of wild geese after

two years in captivity.* It has been found in guinea fowl, pea fowl, goose, duck, dove, canary, and parrot. Among wild birds it has been reported in the swan, stork, crane, vulture, ostrich, pigeon, owl, pheasant, finch, grouse and partridge.

DISSEMINATION—FROM OUTSIDE SOURCES.

BUYING IN NEW STOCK. Probably the commonest method of spread of tuberculosis from flock to flock is by the transfer of infected fowls.



Fig. 5. Liver and spleen from an advanced case of tuberculosis in a hen.

A hen may be quite seriously affected without showing any external symptoms of the disease, and such an individual when introduced into a flock can serve as a source of infection for other fowls on the premises through the droppings as described below.

TRANSMISSION THROUGH EGGS. There is considerable experimental evidence to show that transmission through eggs is a possible means of spread of the disease. As early as 1889 Maffucci inoculated eggs with

* Since this was written the author has seen the disease in a parrot and in hens from two other sources not shown on the map.

tubercle bacilli, incubated them and proved that although the presence of the germs evidently did not hinder the development of the embryo, the bacilli remained alive and later caused disease in the chick. Koch and Rabinowitsch⁹ in examining four hundred and fifty-nine birds from the Berlin Zoological Gardens, found tuberculous ovaries and eggs containing bacilli "in a large number of cases." Rabinowitsch¹⁰ from experiments with thirty-two eggs inoculated with tubercle bacilli of avian,

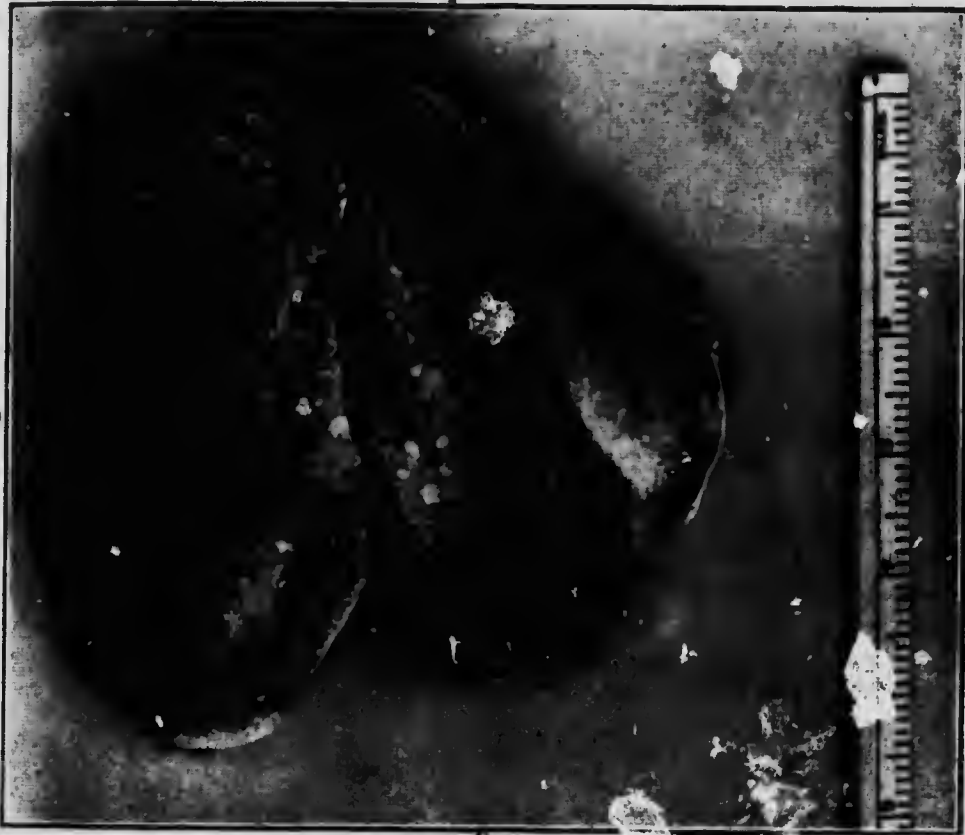


Fig. 6. Liver of a hen greatly enlarged and full of tubercular lesions.

human, and bovine origin, concluded that tuberculosis may be transmitted through the egg. Mohler and Washburn¹¹ report the infection with tuberculosis of guinea pigs inoculated with white of egg from a tubercular hen. In our own work, we have found tuberculous infection of the ovaries in six cases out of forty-six in which the ovaries were examined. Although hens in an advanced stage of the disease do not

usually lay, the possibility of transmission through the egg must be recognized and guarded against in keeping a clean flock.

TRANSMISSION FROM HUMAN AND BOVINE SOURCES. The literature on this phase of the subject is contradictory. Moore,¹² Weber,¹³ Shattock,¹⁴ Zwick,¹⁵ and others, claim that tuberculosis is not intertransmissible between the human or bovine and the avian species. On the other hand, recent researches by Koch and Rabinowitsch,¹⁶ Drew,¹⁷ Morse,¹⁸ Arloing,¹⁹ and others have shown that tuberculosis may be produced in fowls by feeding or direct inoculation with tuberculous material from cattle and from man. Experiments of Rabinowitsch,¹⁶ O. Bang,²⁰ de Jong,²¹ and others have shown that tubercle bacilli from avian sources can infect mammals. Our own investigation along this line has been very limited, but the results thus far obtained indicate that guinea pigs at least may be infected with tubercle bacteria from avian sources. Of six guinea pigs inoculated, two each with pure cultures of the tubercle bacillus from three different hens, one of each pair on post mortem examination one hundred days after inoculation showed positive though not extensive lesions of tuberculosis. The other three pigs are still alive and apparently healthy ten months after inoculation. Of six guinea pigs two each, inoculated with tubercular tissue from three different hens, one pair chloroformed and examined post mortem eighty days after inoculation, showed no sign of tuberculosis. The other two pairs are yet alive and apparently healthy six months and five months respectively after inoculation.

The possibility of infection of hens from "following" tubercular cattle was investigated to a limited extent. Seven one-year old chickens were turned into a shed where all the manure from a herd of twenty-five tubercular cows was stored. After fourteen months the birds were killed and examined, but none showed tubercular infection. Further work should be done along this line, however, before conclusions can be drawn as to the danger of fowls contracting tuberculosis from cattle by this method.

Summing up the results obtained from the latest and most extensive research, it is evident that tuberculosis is intertransmissible between the human or bovine and the avian species, to a certain extent, and that the avian bacillus so called must be considered as not a distinct species, but merely a variety, the differences in character of this organism from the bovine or the human type being due to environment.

DISSEMINATION—IN THE FLOCK.

The most common source of infection in the flock is undoubtedly the droppings of affected birds. When the intestines are affected, some of the tubercles on the intestinal walls may rupture and open into the lumen, discharging the bacilli into the intestinal canal to pass out with the droppings. When the intestines bear these open tubercles the bacilli

may almost invariably be found in the droppings. We have made microscopic examinations of the droppings of fowls in twenty-nine cases in which the intestines were tubercular as shown by subsequent *post mortem* examination, and have found the bacilli present, sometimes in enormous numbers. In a feeding experiment to secure further proof on this point, we selected five healthy hens and two cocks from the College Poultry Department. These were fed droppings from tubercular hens. In all, eleven feeds were given at intervals extending over a period of twenty days. Of the seven thus fed, four died within six



Fig. 7. Liver, spleen and three pieces of intestine from a bad case of tuberculosis in a hen.

months, and autopsy showed them to be tubercular, the infection varying in extent. The other three lived for eleven, twelve and fourteen months respectively, dying from other causes and showing no tuberculosis on *post mortem*. While the number of birds fed was not large, yet the results are conclusive and confirm the general opinion that the tubercle bacilli are most often ingested with food soiled with the droppings of birds having lesions in the intestines. As a control on the birds fed in this experiment we have considered the college flock sufficient, inasmuch as there has never been a case of tuberculosis among the fowls in the college plant.



Fig. 8. Liver, gizzard and intestines from a tubercular hen. The liver is badly diseased and there are some very large, and many small tubercles on the intestines and in the mesentery

DETECTION OF THE DISEASE.

SYMPTOMS. There are no definite symptoms of tuberculosis of birds in the early stages, and for this reason the disease is not usually detected until it has made serious inroads in the flock. Detection by the tuberculin test is unavailable, as shown by results of Ward,²² of Klimmer and Saalbeck,²³ and in this laboratory. Results secured by the author in a test of seven tubercular hens, in comparison with six healthy hens, agreed with those of the two investigators mentioned. Temperatures of healthy and tubercular birds show little or no difference, either before or after the injection of tuberculin.

Usually the first symptom of tuberculosis noticed is emaciation, or "going light," accompanied often though not always with a pale appearance of the comb and wattles and the skin about the head. There is frequently, though not always, a persistent diarrhoea, the droppings appearing of a green or greenish white color. Lameness in one or both legs may occur, due to infection of the joints. In the latter stages of the disease, the feathers become dry and ruffled, the bird becomes weak and mopy and moves but little. The eye is bright and the appetite is usually good throughout the sickness and the affected fowls may eat ravenously until a few days before death occurs.

POST MORTEM APPEARANCE. The first thing noticeable on opening the bird for *post mortem* examination is the characteristic appearance of the liver, known to poultrymen and farmers as "spotted" liver. The liver is studded more or less thickly with rounded tubercles varying in size from a pin point to three-eighths or even one-half inch in diameter. The tubercles are circular in outline, although several, in growing close together, may coalesce to form an irregular area. The tubercles protrude more or less and can usually be readily separated from the surrounding liver tissue. The color of the lesions may be white, creamy white, or yellowish white. In consistency they may be either hard and granular, or they may be soft and cheesy. On section it will be found that the tubercles are not on the surface only, but extend throughout the liver tissue. The organ is usually enlarged, sometimes to more than double the normal size. In one case that came under our observation the weight of the liver was one-fourth the weight of the entire bird. (Fig. 6.) The liver appears to be the first point of attack; at least in one hundred and four cases we have found the liver affected in every case but one, and in a few cases it was the only organ affected. The appearance of the tuberculous liver is illustrated in figures 4, 5, 6, 7 and 8.

The spleen, which in the healthy adult chicken is a rounded, somewhat kidney-shaped, purple organ about half an inch in diameter, and lying under the liver, is almost as frequently affected as the liver itself. Of ninety-seven cases, there were macroscopic lesions in the spleen in all but seven. The spleen is also enlarged, sometimes very greatly.

and the nodules may protrude so as to make the spleen irregular in shape and outline. In one case we examined the spleen was larger than the liver. (Fig. 9.)



Fig. 9. A healthy spleen, in the centre, and four tubercular spleens showing varying degrees of infection.

The intestinal system may be more or less involved. (Figs. 7 and 8.) There appears to be no portion of the intestinal track that is more vulnerable than others, as the nodules are found in different portions in different

cases, and in bad cases may be distributed throughout the length of the intestinal canal and over the mesentery, the tubercles varying in size from a pin head to an inch or more in diameter. When the intestinal tubercles



Fig. 10. The cloaca or lower bowel of a hen, cut lengthwise and laid open to show the tuberculous ulcers on the interior. The healthy cloaca should be smooth over its entire inner surface as shown at the lower border of the picture. The hen from which this was taken was excreting millions of tubercle bacilli daily in the droppings.

are examined they are found many times to have an opening into the lumen of the gut, and microscopic examination of the intestinal contents



Fig. 11. Photomicrograph of tubercle bacilli in a stained preparation from the contents (droppings) of the cloaca shown in Fig. 10. The quantity of droppings containing this cluster of bacteria was far too small to see with the unaided eye.



Fig. 12. Lungs from a hen showing many rounded white tuberculous nodules.

at this point shows the presence of the tubercle bacilli in great numbers. We have always found the intestinal lesions exceptionally rich in the bacilli, and these, discharged into the canal, pass out with the droppings. We have often found these open tuberculous ulcers in the lower portion of the intestines and on the cloaca (the large lower bowel) itself, in which cases the organisms are readily detected in smears made from the droppings. In one case the entire cloacal wall was covered with tuberculous ulcers, many of them opening to the interior. (Fig. 10.) The cloacal contents were extremely rich in tubercle bacteria. (Fig. 11.) This indicates how easily susceptible fowls may contract the disease by ingesting the bacilli from infected birds with soiled food or water. We found the intestines affected in sixty out of ninety-eight birds examined. The lungs are more rarely affected than the liver, spleen, and intes-



Fig. 13. Tuberculosis of the bones. The irregular white areas in the backbone, and the parts indicated by the cross (x) in the ribs and the long bone are the tubercular portions. There were numerous small tubercular lesions in the ribs which the photograph does not show.

tines. When affected, the tubercles are spherical, small and hard, and when present at all are usually numerous. (Fig. 12.)

Other organs less frequently affected are the heart, proventriculus, gizzard, kidneys, ovaries, cervical lymph glands and skin.

The bones are often affected, especially about the knee joint, giving rise to the lameness or "rheumatism," so called, which is one of the characteristic symptoms of the disease. The right knee is more often affected than the left. Only the extremities of the bones usually show any macroscopic lesions, although in bad cases there may be lesions

throughout the length of the femur. In one case which came under observation, the disease had progressed extensively in the skeletal system, the parts affected including both knee and both hip joints, besides lesions in the shaft of the right femur, both shoulder joints, the backbone, the breastbone and ribs, lesions in the last three locations being very numerous. (Fig. 13.) When the bones are affected the lesion is yellowish white and lies just beneath the periosteum, there being no swelling of the surface, except in some rib lesions, in which there may be a marked enlargement in the rib at the location of the tubercle. A characteristic of the bone lesions is the enormous number of bacilli present.

The distribution of the tubercular lesions in the affected fowl is shown in the accompanying table.

TABLE I.—SHOWING DISTRIBUTION OF TUBERCULAR LESIONS IN THE AFFECTED FOWL.

Part affected.	Cases examined.	Affected.	Not affected.	Per cent. affected
Liver	104	103	1	99.1
Spleen	97	90	7	92.7 +
Intestines	98	60	38	61.2
Mesentery	95	20	70	21 +
Lungs	78	15	63	19.23
Ovaries	46	6	40	13 +
Heart	96	2	94	2.08
Gizzard	96	3	93	3.12
Kidney	46	6	40	13.04
Skin	46	3	43	6.52
Bones	46	20	26	43.47

Whenever a fowl dies a *post mortem* examination should be made. This may easily be done in a moment's time by laying the bird on its back, making a large opening in the abdominal cavity just back of the point of the breast bone and breaking the breast bone back toward the head, as shown in Fig. 14. The lungs, heart, liver, gizzard and parts of the intestinal system are thus exposed and any abnormal condition is readily noticed.

When such an examination is made, if the internal organs are affected as described and illustrated, and if the bird before death had been thin, droopy and lame, with a greenish diarrhoea, there is strong evidence that the disease is tuberculosis. A positive diagnosis cannot be made, however, without a microscopic examination to demonstrate the presence of the tubercle bacillus. This is done by subjecting a minute particle of the diseased tissue to a special method of staining, and examination under high magnification, when, if present, the bacilli may be seen as illustrated in Fig. 2. It is only by such a microscopic examination



Fig. 14. A *post mortem* examination of a fowl is easily and quickly made. A large opening is made just back of the point of the breast bone, the skin is torn back and the breast bone is broken backward toward the head. The heart, liver, gizzard and part of the intestines are seen at once, and the other organs are readily accessible. The liver, in the specimen photographed, shows the characteristic tubercular "spots."

that tuberculosis can be positively differentiated from conditions found in "blackhead," "beef scrap liver," "lungers" in chicks, or other diseased conditions. Diseased birds suspected of having tuberculosis may be sent to this laboratory, where a microscopic examination will be made and the result reported to the sender without cost.

CONTROL.

There is little or no satisfaction in attempting to treat individual cases, and the use of drugs is a waste of time, patience and money. When once the disease gains a foothold in the flock, it is difficult to eradicate except by the adoption of drastic measures. The quickest and most effective method is to kill off all of the birds, disinfect the premises as thoroughly as possible, and start with new stock from a flock that is known to be free from disease. In small flocks this method would seem advisable. The fowls could be examined, and all that were found to be free from disease could be sold for market, thus lessening the loss. In large flocks, or where it is desired to preserve a certain strain in breeding, a modified Bang system may be carried out based on the same principles as employed in eradicating tuberculosis from a herd of cattle. All birds that show the least signs of illness should be promptly slaughtered and cremated. The well birds should be removed to new ground, and new houses built; or if the houses already in use are of sanitary construction they may be thoroughly disinfected and whitewashed, after which they may be moved to the new ground and used with safety.

Eggs for hatching should be secured from stock that is known to be healthy. If incubators are used the problem is simple. Keep the chicks entirely separate from the old fowls and only on clean ground, and as they grow up dispose of the old flock to the best advantage possible, again thoroughly disinfecting the houses and runs used by the old flock. If hens are depended on for hatching, the chicks should be taken away as soon as hatched to artificial brooders and raised as already suggested, entirely separate from the old flock. Precautions should also be taken to prevent the possible infection of the fowls from bovine sources by the feeding of offal from slaughtered tubercular cattle or hogs, or from human sources by picking up sputum carelessly expectorated on the ground by consumptive persons.

Care should also be taken in buying new stock to secure birds only from flocks that are known to be free from disease. An additional preventive is to increase and maintain the natural vigor of the fowls by care in breeding and feeding, and housing in open air houses. Too much emphasis cannot be placed upon the value of plenty of fresh air in the house. The disease is most often found in flocks that are over crowded in poorly ventilated houses.

DISINFECTION OF PREMISES.

The first thing to do in putting the poultry premises in sanitary condition is to scrape the roosts, walls, ceilings, floors and nest boxes of the houses thoroughly clean with a hoe or other convenient implement. Accumulated manure may be mixed with lime, spread on the land and plowed under. Loose litter, pieces of boards or other valueless material should be completely burned. When this has been done the entire inside of the houses may be washed down with some good disinfectant such as carbolic acid, one part in twenty of water, zenoleum, lysol, chloronaphtholeum, or other disinfectants in the strengths indicated by the manufacturers. Any of these may be put on with a spray pump. In place of these, quicklime in the form of whitewash may be used, prepared as follows. Slake the quicklime by adding water in the proportion of one and one-half pints of water to each quart of lime or by weight, sixty parts of water to one hundred parts of lime. The resulting dry powder is hydrate of lime. For use mix one quart of this with four quarts of water. This must be freshly prepared in small lots and used immediately. It is best applied by means of a spray pump, although it may be put on with a brush or broom. If a spray pump is used, the slaked lime should be put through a fine sieve or strainer in order to prevent clogging of the nozzle. It is important that every crack and crevice and every particle of surface be covered with the disinfectant. After disinfection, clean boards may be placed beneath the roosts to catch the droppings, thus facilitating the work of future cleaning. Slaked lime placed on these boards will absorb the moisture from the droppings besides adding to their fertilizing value. Disinfection of the houses should be carried out at intervals as long as any diseased birds remain in the flock.

To disinfect the runs is a difficult matter, because it is impossible to have the disinfectant come into contact with each minute particle of soil. The best that can be done is to completely cover the ground with freshly slaked lime and plow under. Sow some quick growing crop for green manure, lime and plow under again. By this method the soil can eventually be well disinfected. The fact must be kept in mind, however, that any tubercular fowls may be continually reinfesting the soil by voiding the tubercle bacilli with their droppings; consequently, it would be impossible to keep the soil free from infection so long as diseased fowls were kept on that ground.

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