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KANSAS STATE COLLEGE OF AGRICULTURE  
AND APPLIED SCIENCE

MANHATTAN, KANSAS

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## POULTRY DISEASES, THEIR PREVEN- TION AND CONTROL



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## POULTRY DISEASES—THEIR PREVENTION AND CONTROL<sup>1</sup>

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Poultry will turn the raw products of the farm into a finished product for the market more rapidly than any other farm animals. Nevertheless, the flock must be given considerable care and attention, proper feed, housing, and sanitary surroundings if it is to be a financial success.

Disease is one of the important reasons for failure in the poultry industry. The poultry raiser is largely responsible for this, since most of these diseases can be controlled with comparatively little effort.

Prevention and not cure is the economical method of controlling diseases. The low unit value of the bird prevents extensive individual treatment. In most cases the time necessary for handling and treatment is worth much more than the individual bird. Consequently control measures which seem desirable must be applied to the flock as a whole rather than to the individual.

It is impossible to estimate the exact losses in farm flocks, because as yet there are no accurate methods of reporting the mortality in poultry due to diseases. Anyone concerned with the poultry industry cannot ignore the hazard of disease. The fight against disease must be carried on more vigorously and successfully if this menace is not to continue as a serious handicap to the poultry industry.

Kansas now ranks tenth in number of fowls raised. In 1943, \$92,256,000 worth of poultry and eggs were produced in Kansas. When one considers that an industry involving such a vast yearly income is at stake, the economic importance of poultry diseases can be placed on a par with the economic importance of the diseases of any other farm animal.

The purpose of this bulletin is to aid in preventing and controlling disease in poultry flocks. It is hoped that it will be of value, not only to the specialist in poultry raising, but also to the general farmer whose birds are a side issue and yet often are an important asset in his business.

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1. Contribution No. 228 from the Department of Bacteriology.
  2. On leave of absence in the Army of the United States.

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## ESSENTIALS OF POULTRY HYGIENE

Sanitation and hygiene are terms which are generally familiar. Hygiene is the art of maintaining the health of an individual or community; while sanitation deals with the principles and methods employed.

In a larger sense sanitation has to deal with all those factors involved in providing a pure water supply, efficient drainage, proper disposal of manure, necessary cleaning and disinfection of houses, proper ventilation, and utilization of sunlight and disease control in general.

**The Cleaning Process.**—The object of cleaning is not so much the removal of all visible dirt and filth collections as the destruction of those invisible forms of life, the disease-producing microorganisms. The bowel discharge from all animals contains an enormous number of organisms which are so small that their form can be observed only by using the high magnifications. The amount of feces that will adhere to the point of a pin will contain an uncountable number of bacteria. The diarrheal discharges from sick birds, in addition, may contain disease-producing organisms and thus become a very serious menace to the health of all other members of the flock. The birds may carry the infectious material on their feet to the feed and water. Thus contaminated grain and water will be consumed, and soon the entire flock may be suffering from some disease. Besides the harmful bacteria in the bowel excreta there are also many other dangerous organisms. Of these, the intestinal round worms and the protozoan parasites deserve mention. These parasites often become so numerous as to result in the death of the bird.

But while control of the so-called internal parasites is a point of major importance, control of the external (skin) parasites—the lice, mites, and others—is also important. Large numbers of external parasites will so lower the vitality of a bird that it is thereby rendered an easy prey to infection. To hold in check the disease-producing organisms, it is also necessary to control external pests. The cleaning process therefore should consist in (1) the removal of the manure and refuse; (2) the use of insecticides to destroy lice and mites; and (3) the use of disinfectants to destroy microorganisms.

The exact methods to be used will vary to some extent with different diseases and with different conditions.

Fortunately, in practice, this scheme can be simplified, since most of the agents that will destroy bacteria are equally destructive to lice and mites. This is not always true of the insecticides, which are not, as a rule, good disinfectants. Kerosene, for example, is good for killing mites, but has little effect upon bacteria.

### Removal of Refuse

The efficiency of a disinfectant depends primarily on the thoroughness with which the houses and premises are cleaned previous to the application of the disinfectant. Solutions will not penetrate into

large masses of refuse and great care should be taken to remove all loose material such as straw and droppings before a disinfectant is applied. The ideal way is to scrub the interior of houses with hot water or lye water after removing the refuse and before applying the disinfectant.

In case disease has appeared, the refuse from the house should be disinfected before removal, thus eliminating the danger of carrying the infection to other parts of the farm. Usually it is best to burn all such refuse or bury it deeply.

**Disinfectants and Insecticides**<sup>3</sup>—One of the very best disinfecting agents is the direct rays of the sun. However, its penetrating power is limited to a thin surface layer and consequently thick clumps of filth are not completely sterilized. Several hours' direct exposure to bright sunshine is necessary even for thin layers.

Apparatus for disinfecting need not be expensive. For a small coop a hand sprayer is sufficient; for a large building a bucket spray pump or "knapsack" sprayer is more desirable. By using some form of pump, disinfectants can be injected forcibly into cracks and crevices that would not be reached by application with broom or brush. The important point is to soak every nook and corner with the disinfectant. The means of application is of less importance.

Many farmers keep on hand so-called stock dips, which are coal tar preparations. These products are, as a rule, very thorough and satisfactory germ destroyers. A safe rule to follow in their application is to use too much rather than too little. Common, but good, disinfectants are carbolic acid, used in a 5 percent solution, and lysol in a 3 percent solution. Potassium permanganate in about a 1 percent solution is somewhat less desirable because of the dark red stains that result when it comes in contact with the skin or clothing, and because it loses strength very quickly in contact with organic matter. Formalin in a 2 percent solution is very good, but is irritating to the nostrils and eyes of the worker. Bichloride of mercury (corrosive sublimate) in a 1 to 1,000 solution is effective, but is very poisonous and corrodes metal so that it should not be used in a metal pump. In some cases dry quicklime, or chloride of lime, sprinkled over a foul or decomposing mass is more convenient and effective than a fluid disinfectant.

In poultry feeding and packing plants the hypochlorites are superior to other disinfectants because the odors do not taint the flesh of the birds as do the coal-tar products. These products are sometimes loosely termed "chlorinated lime" or "bleaching powder." Such material should be used in proportion of one 12-ounce can to 2 gallons of water. Allow to stand until the next day and siphon the clear supernatant fluid into 1-gallon jugs or glass bottles and stopper tightly. The Bureau of Animal Industry recognizes chlorinated lime containing at least 30 percent available chlorine for use in official

8. Dorset, M. 1931. Some common disinfectants. U. S. Dept. Agri. Farmers' Bul. 926, 1-10.  
 McCullough. 1936. Disinfection of poultry yards. Veterinary Medicine. Vol. 31, 386-390.

disinfection when it is used in proportion of one pound to three gallons of water. The effectiveness of this solution will depend entirely on the available chlorine content of the original package. Many of the samples of bleaching powder on the market are of little or no value. The purchaser should insist on a fresh shipment.<sup>4</sup>

At this laboratory many of the trade-preparation disinfectants and stock dips have been tested and usually the phenol coefficient (value compared with carbolic acid) as given by the manufacturers is not far from correct. A disinfectant with a phenol coefficient of 4 is four times as strong as carbolic acid and can be diluted with four times as much water as is used in diluting carbolic acid and still be as effective. When two disinfectants have the same price the one with the higher coefficient is the more economical because it can be diluted more and, therefore, will go further.

A spraying mixture long used with success in this laboratory is 5 percent crude carbolic acid, or a 3 percent solution of liquor cresolis compound. This is sprayed over the walls and floors. After drying it is followed by a spray of whitewash.<sup>5</sup>

The disinfecting action of the carbolic acid or compound cresol is aided directly by the lime, which is both an insecticide and a germicide. The whitewash also aids mechanically by filling the small cracks and crevices, thus preventing mites from finding suitable hiding places.

Crude petroleum (preferably thinned with 1 part kerosene to 4 or 5 parts crude oil) is a good insecticide. Repeat the application after two or four weeks. Pure kerosene will destroy mites, although several applications are necessary since the eggs are not always killed by the treatment. Remember that kerosene has very little effect upon bacteria.<sup>6</sup>

Common lye is also very effective in destroying bacteria. A solution made by adding 1 pound of lye to 15 gallons of water and applied cold is effective in killing most disease-producing bacteria within a few minutes. Since this solution (as well as the other disinfectants) is very irritating to the skin, the use of rubber boots, gloves, aprons, etc., should not be neglected when applying these agents. The birds should not be allowed contact with floors or equipment still wet with disinfectants.

Some authorities recommend painting the roosts, etc., twice each year with undiluted carbolineum or anthracine oil. When the undiluted compound is used one treatment per year is usually sufficient.

One of the most satisfactory disinfecting agents for use about the poultry plant is boiling water. This kills practically all infectious bacteria almost instantly and in addition will also destroy coccidia and worm eggs.

4. Fay, A. C. The preparation, testing, and use of chlorine disinfectants. Kan. Agr. Expt. Sta. Circ. No. 160, July, 1931. (See page 8.)

5. See appendix, page 118.

6. A formula for making a kerosene emulsion that is effective for both mites and bacteria is given in the appendix, page 119.

**Isolation and Quarantine.**— On the average farm, isolation of birds for treatment is expensive. In most cases it is greater economy to kill the sick birds and immediately burn or bury deeply. This is not only cheaper, but it often removes a serious source of infection from the premises.

Isolation means complete separation of the sick from the well birds. An isolation building is ideal, and this should be so located and constructed that it will be impossible for the well birds to come in contact with the sick birds or their droppings. Just as soon as one of the flock shows symptoms of disease it should be removed and either isolated or destroyed. Persons passing back and forth from an isolation house to the healthy birds should take every precaution to prevent the spread of infection by means of contaminated shoes, clothing and hands. The ideal way is not to allow the person feeding the healthy flock to go near the isolation pen. At least, one can wash his hands and shoes with a disinfectant solution when leaving the sick birds. The well birds can always be cared for first and this will lengthen the time between visits and thus minimize the danger of carrying the infection to the healthy fowls.

Birds quarantined on account of sickness should never be put back with the healthy flock, but should be fattened for the market as soon as they are cured. A recovered bird is often a menace to the flock, since it may become a carrier of an infection and the direct cause of another outbreak.

Many outbreaks of disease are started by introducing new stock from other flocks. When new birds are to be introduced into the flock, or when they are to be returned from fairs and shows, they should be quarantined in an isolation house for three weeks before being placed with other birds.

It is always best to ask for a clean bill of health for all new birds purchased for breeding purposes. This is especially true as regards pullorum disease. When eggs are purchased the chicks should be kept by themselves for several days after hatching to avoid introducing pullorum disease, since chicks are nearly always infected through the egg. Sparrows, pigeons and other birds may carry disease from one flock to another, and if there is disease in the locality, wild birds should be kept away from the chicken runs.

Probably the most serious source of disease are visitors, such as testing and culling agents, poultry buyers, remedy agents and salesmen. Such persons visit many farms and rarely use precautions of any sort. The only solution to such a problem is to lock the gate to the poultry yard and install "Keep out" signs everywhere.

Diseases may also be introduced into the state from the outside. Adult birds from pullorum-tested flocks may be shipped into Kansas. While not a Kansas regulation, all birds over two years of age should be free of tuberculosis.

## CARING FOR THE FLOCK<sup>7</sup>

**Houses.**—The living quarters of the flock require as much attention as do those of other classes of livestock if the fowls are to be kept free from disease. Space will not permit a discussion of poultry-house construction, but a few of the important essentials that should be considered in connection with prevention of diseases are mentioned. First of all, the house<sup>8</sup> should be constructed to insure dryness at all times, since dampness promotes the growth of bacteria and makes the birds subject to colds, roup, and other diseases. Ventilation without drafts is essential, for fowls require more oxygen per pound of body weight than do most animals. Birds do not have sweat glands in the skin, so that the moisture is eliminated through the lungs. Since the metabolism of the bird is very high, 1,000 pounds of live weight of fowl requiring two or three times as much air as an equal live weight of horse or cow, large amounts of moisture are eliminated that must be removed by ventilation if the house is to be kept dry. Plenty of room should be provided in order to avoid crowding the birds. At least three and one-half square feet per bird is advisable. Houses should face the south and be provided with a large open front through which direct sunlight can be directed into the interior. Sunlight is an efficient and cheap disinfectant. Lastly, the interior of the house should be constructed to prevent drafts and to facilitate easy cleaning and disinfection. The ideal house has all nests, roosts, etc., removable, thus minimizing the labor required. Colony houses for growing birds can be readily moved to new fields and thus keep the birds on clean, fresh soil.

**Runs.**—If the flock must be reared under intensive methods, rotation of yards is the ideal toward which to work. Four fenced-in runs should be provided for each house. By this plan, plenty of green feed can be grown and the cropping of the runs aids in keeping down infection. Crowding too many birds into one yard should be avoided. If rotation is impossible, great care must be taken to clean the runs often and keep them well limed.

Where it is impossible to rotate runs, and cement runs are too expensive, a layer of six inches of coarse gravel should cover the entire yard and great care should be exercised to avoid mud holes and wet spots where coccidia and worm eggs remain viable for long periods of time.

Sanitary runways have the advantage over dirt, cement or gravel runs in that they are easier to keep in a clean and satisfactory condition and they are relatively inexpensive to construct. (See Kan. Agr. Expt. Sta. Circ. 178, 1936.)

**Utensils.**—Good feed and water utensils, from the standpoint of disease prevention, must be easy to clean and disinfect and must be

7. For reliable and detailed information on any phase of poultry management the reader is referred to Circ. 178, Kan. Agr. Expt. Sta. 1936, by L. F. Payne, or to some recent textbook on Poultry Production.

8. Write the Department of Poultry Husbandry, Kansas State College for details.

so constructed that birds cannot contaminate them with droppings. Watering utensils should be of a material that will not be affected by antiseptics that are placed in the water. Crockery or glass containers are ideal for this purpose, but have the disadvantage of breaking in freezing weather. Wooden troughs have a disadvantage in that many solutions lose strength rapidly when placed in them, while iron vessels react chemically with some drugs, causing loss of strength in a very short time. Enamel ware is satisfactory for the purpose.

Most diseases are spread through contaminated water, feed and air. Keeping utensils clean will do much to minimize this source of infection. Many forms of feeding and watering pans, troughs, etc., are on the market, and plans for homemade devices are found in many textbooks and bulletins on poultry production. The important point is to keep all these utensils clean and sanitary at all times.

Scratch feed that is fed out of doors should be placed in feeders or on clean, dry areas. Feed continually thrown in one place means heavy contamination of that spot and it is therefore necessary to change feeding areas often.

### VIGOR OF STOCK

All breeds have some advantages and disadvantages and all are subject to disease. However, the bird that is vigorous, is well up on its feet, has a good color, is full-sized and a leader, will remain healthy longer than the one that is thin, scrawny, undersized, and weak. Excessive fat in a hen indicates lack of exercise or lowered vigor and such a bird may succumb to disease more quickly than the one that exercises of its own free will.

Continual selection and rigid culling of the flock will do more than anything else to increase the percentage of high producers and eliminate unfit birds. These precautions are an insurance against disease, since they help to keep weaklings out of the flock.

Kansas poultrymen interested in better poultry should write the Department of Poultry Husbandry of the Agricultural Experiment Station for their program of flock improvement.

### HEALTH FEEDING

Great care should be exercised to feed the birds properly. Even birds that have the run of the farm do not always obtain a balanced ration, especially in the late summer and winter. Besides the usual feed of protein, carbohydrates, fat, and ash, birds require vitamins in order to develop and function properly. Vitamins are found normally in whole milk, grass, green leaves, fruits, the covering of grain, in cultures of certain yeasts and bacteria, and in the glandular and some other tissue of animals. They are not found in abundance in muscle tissue, in tubers, or white flour. At present several different vitamins are required by poultry. A lack of one or more of these in the feed may lead to certain characteristic symptoms in the affected bird as described later.

Quite frequently serious damage to the production and health of the flock is brought about when a sufficient supply of fresh, clean water is not provided. Water should be changed three times daily if there is disease in the flock.

Diseases due to improper feeding have been recognized for many years, but exact knowledge of the lacking elements has been available for only a short time. Some feeding practices which are injurious to the health of poultry are (1) overfeeding, (2) feeding too high concentrations of protein, (3) sudden changes in feeds, (4) irregular feeding periods. It is well recognized that too high protein feeds frequently cause severe enteritis in birds and animals. If this type of feeding continues the death losses may be very heavy.

Prof. L. F. Payne of the Department of Poultry Husbandry at this college has contributed the following statement in regard to the role of grass in the poultry diet:

"The cultivated tame grasses such as oats, barley, wheat, rye, and sudan, have proved to be good supplementary poultry feeds for the grain ration. These grasses possess all of the well-known vitamins except D, which is available in the direct sunshine, and they are rich in the important minerals and in protein. In Kansas the grasses reach their maximum in nutritive value 20 to 25 days after coming through the ground or just before the stock begins to joint, and the carotene and protein content declines rapidly after reaching this stage of development. These grasses, when fed liberally to the growing and laying flocks, appear to build up resistance to parasites and to certain diseases. Grass feeding also reduces the amount of grain consumed, thus lowering the cost of production.

"A method for providing young, tender grass throughout most of the year at the Kansas State College poultry farm is as follows: Oats are drilled on well fertilized soil at the rate of 2 bushels per acre as early in March as the weather will permit. Different seedings are made at 2-week intervals to insure a continuous supply of tender, green feed until about June 1. When the oats are 4 to 6 inches tall, they are cut near the ground, put through a feed chopper, and supplied liberally to the growing chicks early each morning. Oak are preferred to the other grasses for both spring and fall feeding since they seem to be more palatable than the other grasses or legumes. They produce more herbage than wheat, barley, or rye, and are economical and easy to grow. For summer green feed, sudan grass is drilled in rows early in May and it is ready to begin feeding by June 1. It is cut at frequent intervals before jointing during the summer and early fall, put through the feed chopper and fed as described for the oats. While sudan can be depended upon until heavy frosts, it is more satisfactory to again drill oats about September 20, as they will grow quickly, yield better, and withstand the early frosts. One hundred mature pullets will consume 3 to 4 pounds daily.

"This method will provide green feed for approximately 7 or 8 months during the year. For the winter months alfalfa leaf meal made from the last cutting in the fall has proved to be a good source of green feed. Oat plant silage, preserved in pit silos with mineral acid and with molasses, and dehydrated grass meal preserved in buttermilk have been used as winter green feed, but it is too early to say which of these methods will prove to be the more practicable.

"While the soiling method of feeding, as described above, has given satisfactory results the frequent seeding, pasturing, and moving of the colony houses, as practiced by Prof. W. R. Graham at the Guelph, Ontario, Agricultural College, has also proved very satisfactory under their climatic conditions. The extending of the pasture season throughout the year by feeding and preserving the grasses at their maximum in nutritive value is a recent and valuable contribution to poultry nutrition. This system not only enables one

to produce better stock, but also the eggs produced by such flocks probably have a more uniform and higher nutritive value for human consumption."<sup>9</sup>

### DISEASES OF POULTRY

The following pages are devoted to a discussion of some of the more common diseases known to be present in Kansas and surrounding states. New diseases are occasionally discovered and undoubtedly, as the poultry population becomes more extensive and as new birds are shipped into the state from different sources, still more diseases will appear.

Since the poultry industry is so closely associated with the agricultural industry of the state, all people engaged in farming should have some knowledge of poultry diseases and methods for their control. The low unit value and short life of the bird often makes disease control in poultry a more simple problem than control of diseases of other classes of livestock.

**General Discussion of Poultry Diseases.**—The term disease in its broadest sense means any deviation from the normal. Consequently, any factor that interferes with the fullest performance of the normal functions of growth, development, or egg production is to be regarded as causing disease. Underfeeding or overfeeding, excess of heat or cold, lack of water, or annoyances by lice, mites, worms or other parasites, and infections by bacteria are all capable of disturbing the normal state of health and must therefore be considered as causing disease.

When disease appears in a flock of birds the owner immediately wishes to know what can be done to control it. Poultrymen are agreed that individual treatment is not desirable except in case of especially valuable birds. From experience at this station it has been found about as easy to cure sick birds by proper treatment and nursing as it is to cure any other sick animals by this means. There are certain objections to curing sick birds inasmuch as the recovered cases show inferior stamina, vigor, and resistance to disease. Furthermore, it is possible that the recovered bird may be a source of danger to other birds on the premises. It may still be a "carrier" of the disease even though immune itself. In man this possibility has been established beyond doubt in several diseases where it is known that occasional individuals that have recovered still carry the infectious organism and are a danger to others.

It is known that many cases of annual or periodic outbreaks of fowl cholera, infectious laryngotracheitis and fowl pox are due to recovered cases which are "carriers."

A very important point in disease control, and one which is commonly overlooked by the flock owners, is the various ways in which diseases are brought to the farm. Strangers or neighbors visiting the houses and yards is a very important means of introducing bacteria, coccidia, worm eggs, and viruses. These germs are also pres-

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<sup>9</sup> For further information on the subject see Kan. Agri. Exp. Sta. Bulletin 320. Grass and alfalfa as silage, forage and meal for poultry. 1948.

ent on crates, which are carried from farm to farm, and on feed sacks which are returned to the mills to be refilled with feed. In some instances farm animals and the owner may act as a mechanical carrier of germs. The careful poultryman will not allow visitors in his yards, or use feed sacks or crates which have been used by another poultryman.

Much of the information included in this bulletin has been gained from some 25 years of investigation on poultry diseases at this Agricultural Experiment Station. During that time we have studied some 75,000 birds from nearly 25,000 outbreaks. The list of disease conditions studied has now become too long to be included in this publication.

In a few instances diseases have been described which are not common in Kansas at present but which may be introduced into the state at any time.

Table I shows the seasonal distribution of some of the more common diseases of poultry. By a careful study of such figures it is sometimes possible to come quickly to an accurate diagnosis. This is especially valuable in the field where microscopic and cultural methods are not available. The data from which this table was compiled have been collected over a period of years at this station. The graphs in figure 1 were plotted from the figures in Table 1.

**What to do in Case of an Outbreak of Disease.**—During recent years the veterinarian has become familiar with diseases of poultry and their control, and whenever it is possible he should be consulted. He has the advantage of experience, can see unfavorable conditions as they exist on the farm, and can often prevent a large loss by his timely treatment. It is often impossible to make a correct diagnosis without a bacteriological study, but if such cases arise the veterinarian can give immediate attention to preventing a spread of the disease until he can send some sick birds to a laboratory for further study. By the time a letter is written to the college for advice, or birds shipped for direct examination, a week may have elapsed before treatment can be started. Therefore, it will usually pay to get the advice of the veterinarian as soon as a disease outbreak is observed in the flock.

**Ship Birds to the College.**—If a definite diagnosis cannot be made from the symptoms given in this bulletin, two or more live birds in the first stages of disease should be shipped to the college for examination. Birds that show characteristic symptoms should be selected and shipped by prepaid express to the Department of Bacteriology, Kansas State College, Manhattan, Kan. A letter giving the following information should be mailed at the time the birds are shipped:<sup>10</sup> (1) History of the outbreak; (2) age of the birds affected; (3) a full description of the symptoms; (4) number in the

10. This is of special importance.

TABLE 1.—DISTRIBUTION BY MONTHS OF 10,000 OUTBREAKS OF POULTRY DISEASES IN KANSAS

DISEASE.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
<b>FOWL CHOLERA:</b>													
Number.....	129.0	146.0	146.0	47.0	40.0	15.0	3.0	27.0	34.0	73.0	71.0	87.0	853
Percent.....	15.1	17.1	17.1	5.5	4.6	1.7	4.4	3.2	3.9	8.6	8.4	10.4	
<b>FOWL TYPHOID:</b>													
Number.....	18.0	16.0	28.0	21.0	34.0	43.0	47.0	48.0	39.0	36.0	25.0	8.0	363
Percent.....	5.0	3.6	7.9	5.9	9.5	11.8	13.1	13.6	10.9	10.0	6.8	2.3	
<b>PULLORUM DISEASE:</b>													
Number.....	33.0	116.0	440.0	492.0	457.0	107.0	38.0	31.0	8.0	18.0	12.0	8.0	1,760
Percent.....	1.9	6.8	25.0	28.0	26.0	6.1	2.2	1.8	0.5	1.0	0.7	0.5	
<b>TUBERCULOSIS:</b>													
Number.....	33.0	39.0	51.0	52.0	54.0	36.0	25.0	26.0	26.0	26.0	31.0	31.0	430
Percent.....	7.6	9.1	11.8	12.2	12.6	8.0	5.8	6.1	6.1	6.1	9.3	7.3	
<b>BOTULISM:</b>													
Number.....	0.0	0.0	0.0	3.0	8.0	26.0	43.0	35.0	30.0	16.0	7.0	0.0	168
Percent.....	0.0	0.0	0.0	2.0	4.9	15.6	25.5	20.6	17.6	9.8	3.9	0.0	
<b>BLACKHEAD:</b>													
Number.....	3.0	2.0	3.0	7.0	13.0	23.0	21.0	3.0	13.0	35.0	13.0	6.0	142
Percent.....	2.3	1.3	2.3	4.6	9.3	16.3	15.1	2.3	9.3	24.4	9.3	3.5	
<b>COCCIDIOSIS:</b>													
Number.....	33.0	22.0	56.0	119.0	265.0	230.0	128.0	62.0	50.0	38.0	23.0	25.0	1,051
Percent.....	3.1	2.1	5.3	11.3	25.2	21.8	12.1	5.9	4.7	6	2.2	2.3	
<b>WORM INFESTATION:</b>													
Number.....	304.0	222.0	222.0	208.0	319.0	401.0	527.0	594.0	647.0	585.0	420.0	382.0	4,831
Percent.....	6.3	4.6	4.6	4.3	6.6	8.3	10.9	12.3	13.4	12.1	8.7	7.9	
<b>A-AVITAMINOSIS:</b>													
Number.....	16.0	36.0	78.0	78.0	53.0	35.0	33.0	32.0	15.0	8.0	11.0	7.0	402
Percent.....	4.1	9.0	19.7	19.7	13.1	8.6	8.1	7.7	3.7	2.1	2.5	1.7	

POULTRY DISEASES

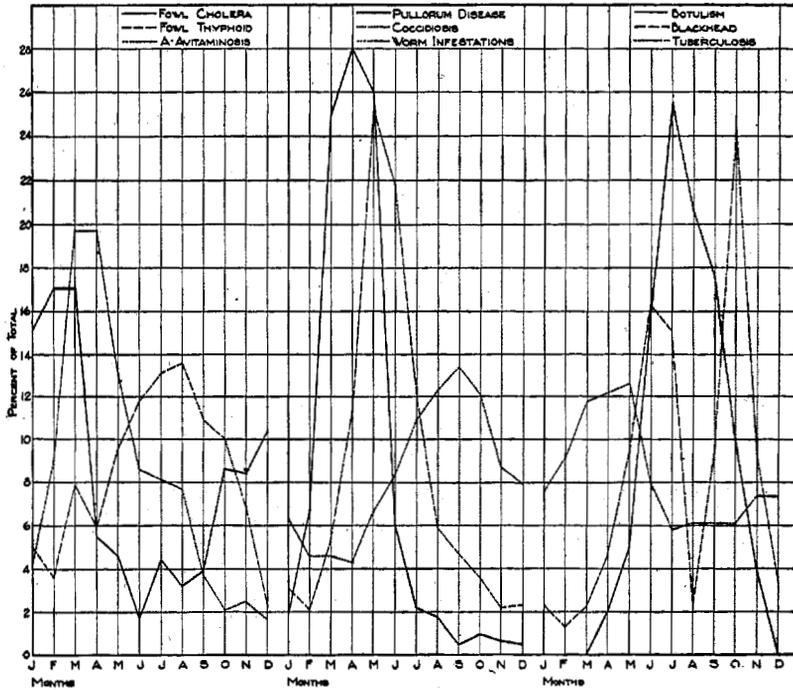


FIG. 1.—Graphs showing the seasonal distribution of some of the more common poultry diseases in Kansas.

flock; (5) the feed; (6) the treatment that has been given; and (7) a description of the condition of the runs, houses, etc. It sometimes requires two or three days before a correct diagnosis can be made, but a reply giving the diagnosis and advice on control will be forwarded as soon as possible after the receipt of the specimens.

Whenever an outbreak of a disease occurs the precautions given below should be observed until a diagnosis and method of treatment can be determined. These measures, if applied in time, should serve greatly to limit the spread of most infectious diseases:

1. Isolate or kill all affected birds. Do not attempt isolation unless the sick birds can be placed where the well birds cannot come in contact with them. It is even better to move the well birds to noninfected quarters.
2. Bury deeply or burn all dead birds.
3. Clean and thoroughly disinfect all coops. Remove and burn all refuse from houses and runs. Lime and plow the ground.
4. Keep fresh water before the birds at all times. Add potassium permanganate<sup>11</sup> to the drinking water (1 level teaspoonful for each

11. See appendix, page 118, for instruction regarding the preparation of drinking water.

5 gallons). This acts as a preventive measure in that it inhibits the growth of bacteria, but it is not to be considered as a cure for the disease. This solution should be used in crockery or enamel-ware vessels, since it soon becomes useless in iron or galvanized fountains. The solution should be changed as soon as it turns brown, and kept before the birds continually.

In case of an outbreak of coccidiosis it will be necessary to scald the utensils with boiling-hot water, since it is not possible to destroy the cysts with the usual disinfectants.

5. Investigate the feed and see that the birds are getting a balanced ration and plenty of green feed.

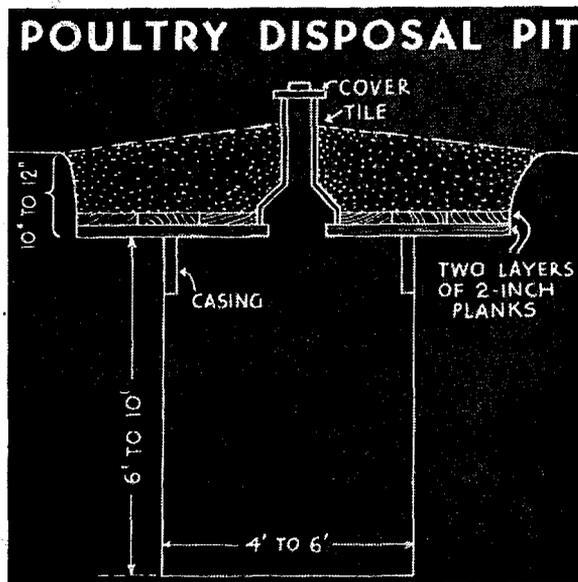


FIG 2.—Poultry disposal pit for dead birds.

6. Unless the droppings are very fluid or bloody, give the birds Epsom salt at the rate of 1 pound per 100 adult birds, reducing the dosage according to the age and size of the birds. This may be mixed in a wet mash and distributed so that each bird will get its share. Another method is to add 4 ounces of Epsom salt to each gallon of water. Place this before the birds from seven o'clock until eleven o'clock in the morning as the only source of water. The birds should then be given all the fresh water they require. Since Epsom salt has a rather severe dehydrating effect, it is advisable to give laxative feeds instead of salts whenever possible.

Figure 2 illustrates the cross section of a pit for the disposal of dead birds. The measurements are indicated in the illustration. (Courtesy Prof. E. I. Robertson, Cornell University, Ithaca, New York.)

**SCHEME TO AID IN DIAGNOSIS OF POULTRY DISEASES**

<i>External Symptoms</i>	<i>Diseases</i>
COMB.....	Congested (deep red)..... (Cholera (early) Botulism)
	Cyanotic (purple)..... (Cholera (late) Blackhead Trichomoniasis, or Hexamitiasis (Turkey) Pneumo-encephalitis Pullet disease)
	Anaemic (pale)..... Tuberculosis Air sac mites Intestinal parasites (worms) Fowl typhoid A-avitaminosis Lice and mites Coccidiosis Leucosis (pale or yellow) Fowl pox
EYES, NOS- TRILS AND SINUSES.....	Tumors..... Fowl pox Nonspecific Colds Ophthalmia (ocular roup) Coccidiosis
	Exudate in..... A-avitaminosis Sod disease Sinusitis Pneumo-encephalitis
	Blindness..... Neurolymphomatosis
MOUTH AND THROAT.....	Ulcers in..... Injuries Avian diphtheria (roup) Trichomoniasis Pox
	FEATHERS.....
Falling out..... Depluming mites Feather pulling Botulism	
WINGS (dropped).....	Intestinal parasites (late stages) Lice and mites Pullorum disease A-avitaminosis Coccidiosis Blackhead All acute diseases
LAMENESS.....	Scaly leg B-avitaminosis Colibacillosis Bumble foot Tuberculosis Sod disease Rheumatism Injury Gout Osteitis deformans Osteopetrosis Perosis Range paralysis

POULTRY DISEASES

SCHEME TO AID IN DIAGNOSIS OF POULTRY DISEASES—CONTINUED

<i>External Symptoms</i>	<i>Diseases</i>
PARALYSIS.....	B-avitaminosis Coccidiosis Tapeworms D-avitaminosis Tumors Leucosis (Range paralysis) Unbalanced ration Botulism Perosis
LEGS AND FEET.....	Rickets..... D-aviataminosis Dry and rough..... Scaly leg Blisters..... Sod disease Foot swollen..... Bumblefoot
	(Tuberculosis P. avicida infection Gout Rheumatism Rickets
	Slipped tendon..... Perosis
NECK.....	(Cholera (late) Botulism
	(Lice in ear Poisoning Worms Ocular roup (ophthalmia) Leucosis Encephalomalacia
VENT (inflamed and protruding).....	(Prolapse of oviduct Inflammation of cloaca Vent gleet
EMACIATION (loss of flesh).....	(Tuberculosis Air sac mites Intestinal parasites A-avitaminosis Blackhead Intestinal coccidiosis (chronic) Cholera (chronic) Leucosis
DIARRHEA.....	(Pneumo-encephalitis Fowl typhoid Leucosis
	(Tuberculosis (late) Worms Pullorum disease Cholera Botulism A-avitaminosis Coccidiosis Colibacillosis Sand scours Pullet disease
	(Cholera Blackhead (sulphur droppings)
	(Coccidiosis Cholera
TEMPERATURE.....	(Pneumo-encephalitis Cholera Fowl typhoid Blackhead Pullorum disease Tuberculosis (late stages) Infectious laryngotracheitis Pseudopest Fowl plague
	(Botulism A-avitaminosis

SCHEME TO AID IN DIAGNOSIS OF POULTRY DISEASES—CONTINUED

<i>External Symptoms</i>		<i>Diseases</i>
DIFFICULT RESPIRATION.....		Infectious laryngotracheitis Avian diphtheria Gapes Aspergillosis (rare in chickens) Pneumonia Heat prostration Infectious bronchitis Pneumo-encephalitis
<i>Internal Symptoms</i>		<i>Diseases</i>
ESOPHAGUS (nodules in).....		A-avitaminosis Trichomoniasis
LIVER.....	Enlarged.....	Pneumo-encephalitis (green colored) Fowl typhoid (mahogany colored) Leucosis Blackhead Apoplectiform septicemia Tuberculosis Tumors
	White spots.....	Blackhead Tuberculosis Fowl typhoid (white or gray) Tumors Pullorum disease
	Yellow (in chicks).....	Chilling Overheating Sand scours Pullorum disease (After 7 or 8 days of age.) Pantothenic acid deficiency
INTESTINAL TRACT.....	Congestion.....	Too high protein diet Colibacillosis Cholera Worms Coccidiosis Poisoning B-avitaminosis Apoplectiform septicemia Fowl typhoid Pullet disease
	Thickened wall or ulcers.....	Worms Coccidiosis Tuberculosis Blackhead
	Nodules on wall.....	Tuberculosis Tapeworms ( <i>Raillietina echinobothrida</i> )
KIDNEYS.....	Ureters distended with urates.....	A-avitaminosis Cholera (late)
	Enlarged.....	Fowl typhoid A-avitaminosis Leucosis
OVARIES.....	Hard, shrunken, angular, dark, brown, or greenish.....	Pullorum disease (other infections rare)
	Enlarged, firm, pale.....	Tumors Leucosis
HEART.....	Petechiae (small hemorrhages).....	Cholera
	Grayish spots.....	Fowl typhoid Pullorum disease Leucosis

POULTRY DISEASES

SCHEME TO AID IN DIAGNOSIS OF POULTRY DISEASES—CONCLUDED

<i>Internal Symptoms</i>	<i>Diseases</i>
LUNGS.....	Congestion (filled with blood)..... Cholera Nodules (in chicks)..... Pullorum Dark, gray, firm, pus in..... {Pneumonia Aspergillosis
TRACHEA AND BRONCHI.....	Congestion..... {Infectious laryngotracheitis (flu) and infectious bronchitis Pus in..... {Pneumo-encephalitis Gapes Worms in.....
AIR SACS.....	Filled with pus..... Aspergillosis Walls thickened and containing fluid... Pneumo-encephalitis Distended with food..... Crop bound Filled with feathers..... Depraved appetite
CROP.....	Mucosa inflamed..... {Worms Poisoning Putrid odor..... {Botulism Trichomoniasis A-avitaminosis
FAT.....	White..... A-avitaminosis Yellowish spots in..... Connective tissue mites
CONNECTIVE TISSUE.....	Darker than normal..... B-avitaminosis Minute yellow spots on air sacs..... Air sac mites
GIZZARD.....	Lining, loose..... {Alkali poisoning Worms Lining, eroded..... {Lack of vitamins Lack gizzard factor
CECA.....	Enlarged, necrotic areas..... Blackhead Filled with blood..... Coccidiosis
YOLK (unabsorbed).....	Pullorum disease in chicks over 8 days of age

It will not be possible in all cases to make a diagnosis by the above symptoms. Certain diseases can be diagnosed only in a bacteriological laboratory by use of cultural and microscopical examinations.

**Autopsy of the Fowl.**—It is seldom possible to make an accurate diagnosis by means of symptoms alone. A bird may show certain symptoms that will indicate several diseases.

As an example, a bird may show an anaemic comb and emaciation and be suffering from tuberculosis, air sac mites, intestinal parasites, lice or mites, fowl typhoid, or nutritional disease. Lameness may indicate scaly leg, B-avitaminosis, bumblefoot, tuberculosis, sod disease, or injury. While the symptoms exhibited by a living bird may be of considerable value in indicating a certain disease, a post-mortem examination will usually lead to a more exact diagnosis. The low unit value of the bird makes it possible to destroy several for examination.

**How to Kill the Bird.**—In killing the sick bird, care should be exercised not to scatter blood where it may transmit disease-producing organisms to other birds. This may be done by breaking the neck. To do this grasp both the legs and wings in the left hand and the head in the right hand in such a way that the back or side of the head rests in the palm of the hand and the base of the skull between the thumb and forefinger. Grasp the head firmly and pull slowly down on the head until the neck is broken. The pressure should be discontinued as soon as the vertebrae are pulled apart. If this is carefully done the skin will not be broken and blood will not be lost to contaminate the soil.

**Post-mortem Examination.**—The body should be examined closely for lice and mites. Observations are also made of the general condition of the head, eyes, nostrils, skin and feathers. Special note should be made of any evidence of diarrhea. Several minutes after the bird has been killed it should be thoroughly wet with water and opened in such a way as to expose the internal organs. This may be done by laying the fowl on its back, cutting the skin between the legs and the body, and then making a cross cut just back of the end of the breast bone. The legs are then pulled away from the body until they are thrown out of joint, and the skin pulled forward and back to expose the entire surface. A cut is then made through the muscles just back of the point of the breast bone and forward through the ribs on each side in the direction of the attachment of the wings. This cut can best be made with strong scissors. Care should be exercised not to injure the internal organs during this operation. The coracoid and clavicle (wishbone) may be crushed with a pair of pliers in old birds, or broken by pulling the entire breast forward while the back of the bird is held firmly to the table. This operation will expose the liver, heart, lungs, spleen, and intestines. These should be examined carefully for size, color, consistency, etc., before they are removed. After this examination is complete the organs may be removed and dissected. The intestines are

removed and split open from end to end with a pair of scissors. A careful examination should be made for thickening of the walls, hemorrhage, ulcers, worms, etc. The contents of the ceca (blind gut) should be examined carefully for very small hair-like worms. These are likely to be overlooked unless special care is used in searching for them. The contents of the gizzard and crop should be examined carefully and the odor noted. The contents of the crop is usually without special odor. In botulinus poisoning, pneumoencephalitis, and flagellosis the odor may be putrid. In the latter disease there is evidence of ulcers on the walls. The contents of the gizzard normally have a sour odor, but in some cases, as in botulinus poisoning, there may be a putrid odor. The esophagus and trachea should be dissected out and split open for examination. In some cases of canker, fowl pox, and laryngotracheitis the upper end of the trachea may be plugged with a yellowish exudate, while in nutritional disease the upper third of the esophagus may be covered with nodules. The kidneys, heart, and lungs should then be examined for signs of abnormality. All post-mortem work should be done in the direct sunlight so that small variations from the normal may be easily noted.

### DISEASES OF POULTRY DUE TO AN UNBALANCED OR DEFICIENT DIET

It is important to recognize that diseases are due not only to specific infections, but also to lack of some necessary element or substance in the diet; to an improper balance between the necessary substances; or occasionally to a marked excess of some food factor.

When animals are undernourished, either with regard to the quality or quantity of the feed, they become far more susceptible to disease than when under a proper system of feeding or nutrition. Sanitation is of little avail in promoting the health of the flock unless it is properly nourished.

Among the nutritional disorders, those due to vitamin deficiencies are highly important. Mineral deficiencies alone, or accompanying a lack of one or more vitamins are occasionally responsible for serious difficulty in poultry.

*A-Avitaminosis (Nutritional Disease).*—When pro-vitamin A is available in the ration in quantities greater than necessary for carrying on the normal functions of the animal body it is stored in the tissues. Therefore, the individual is protected for a short time against an insufficient amount, or no vitamin A at all. The amount of vitamin A stored in the body organs, and the circumstances which determine how rapidly it is used during periods of vitamin A starvation, will determine how soon the deficiency will become evident.

The fact must not be overlooked that the amount of any vitamin which is necessary to prevent outward signs of ill health is considerably less than the quantity that gives the fullest protection against decreased vigor and disease. Usually vitamin A deficiency in poultry is recognized only after it has advanced to a serious stage. Par-

tial vitamin A starvation is much more common among poultry than is generally recognized. It is prevalent during hot, dry summers and in closely confined flocks that are not supplied with additional sources of vitamin A. The laying hen requires a large amount of this vitamin to compensate for the large quantities diverted to the egg yolk. Any degree of vitamin A deficiency increases the susceptibility to colds and other infections.

Eggs from parent stock that is suffering from advanced vitamin A starvation show low fertility and hatchability. The eggs which hatch yield a high percentage of weak chicks, some of which die within a few days to several weeks, even though they are provided a satisfactory ration. Baby chicks from healthy parent stock when deprived of vitamin A grow normally for about three weeks after hatching. During this time they use up the supply of vitamin A stored in the absorbed yolk. Growth then ceases, there may be a loss of weight and the chicks become weak, stagger, and later are unable to stand. The eyes become sensitive to light, and swelling of the surrounding tissues accompanied by the collection of a white mass or exudate beneath the eyelids may occur in some cases.

In mature, or nearly mature chickens, typical advanced cases of vitamin A deficiency may not develop for one to several months after being placed on a ration lacking vitamin A. Diarrhea, with considerable white material (urates) in the droppings, may be seen in the late stages. The collection of white exudate in the eyes is usually more marked than in young chicks. At the California Agricultural Experiment Station turkey poults that were kept in the same pens with chicks on a vitamin A free ration developed symptoms fully a week before the chicks and were all dead in 45 days, while some of the chicks survived for 60 days. Other tests showed that the vitamin A requirements are almost twice as great for young turkeys as for chicks. The symptoms in young turkeys differed from those usually seen in chicks. The lungs were extensively affected and the changes in other organs resembled those found in some acute infectious diseases. In chicks two or three months of age nervous symptoms, incoordination, and leg weakness are common symptoms.

A differentiation should be made between "ocular roup" and the rouplike condition seen in A-avitaminosis. In the former the exudate is more yellowish and cheesy and usually has an offensive odor. In nutritional disease the exudate is nearly white, without a putrid odor, and is easily removed from the eye. One of the most important features which may be followed in the differentiation of these two diseases is the appearance of the lining of the esophagus (gullet). In many birds affected with A-avitaminosis there are found small white or yellowish raised nodules in the mucous membrane about the size of a millet seed. (Fig. 3.) These may be few or many in number and may be located near the upper end of the esophagus, or scattered over the entire surface. The borders of the nodules are regular in outline, a condition which distinguishes them

from those seen in the diptheritic roup. In some cases, however, birds may be suffering from both these diseases at the same time.

In addition to the nodules in the esophagus, birds suffering from nutritional disease may show very characteristic changes in the kidneys. They appear enlarged, pale in color, and streaked with a network of white lines. These lines are due to the presence of excessive deposits of urates. Occasionally a general distribution of urates occurs throughout the body on the surface of the intestinal organs and on the heart which appears as if sprinkled with a white powder. In young birds the bursa of Fabricius becomes distended with a white exudate.

Sources of pro-vitamin A are alfalfa, lettuce, spinach, and other thin leafed plants; yellow corn, carrots, and cod-liver oil are abun-

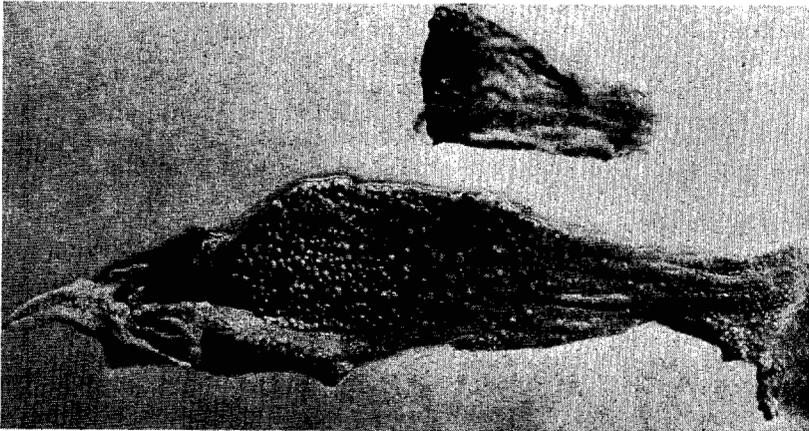


FIG. 3.—Characteristic nodular lesions as seen in the lining of the esophagus of a bird having died from A-avitaminosis.

dant natural sources of pro-vitamin A. These substances contain carotene, a substance which is converted into vitamin A in the body. Plants growing under conditions of drought or other unfavorable conditions may be low in carotene—likewise exposure to moisture and excessive sunlight during curing may destroy a large portion of the carotene in plants. When it is necessary to add cod-liver oil to a ration as a source of vitamin A, only a product known to contain a high concentration of this vitamin should be accepted. Much oil of inferior quality is now being sold on the Kansas market.

**D-Avitaminosis (Rickets).**—Vitamin D deficiency results in the development of rickets, a condition which is quite common in poultry. Several sterols can acquire vitamin D potency on being exposed to ultraviolet light. Among these are ergosterol found in yeast and cholesterol found in the skin, fur and feathers. These acquire vitamin D activity through the absorption of ultraviolet light.

In growing birds considerable quantities of vitamin D are necessary to allow for the assimilation of necessary minerals, particularly calcium and phosphorus. Only with the essential amount of minerals, as well as vitamin D, can normal calcification and development of the bones occur. Rickets may develop in mature birds, but a lack of vitamin D is manifested chiefly by the laying of thin-shelled or soft-shelled eggs and, finally, a failure of the hen to produce at all. The hatchability is lowered or destroyed and the offspring of rachitic hens may show evidence of rickets soon after hatching.

In growing chicks the first evidence of rickets appears as a leg weakness, and an inclination to rest on the hocks rather than to stand. This condition may become more pronounced and in some instances accompanied by increased nervous excitability. Eventually the chicks may be unable to stand, and the bones as well as the beak become abnormally soft, elastic, and often crooked. The joints may be enlarged and "beading" of the ribs is observed. The feathers appear dull and rough and the comb pale.<sup>12</sup>

Sunlight as well as other forms of light which contain ultraviolet rays serve the same practical purpose as vitamin D. The quantity of effective ultraviolet rays in sunlight varies greatly during different seasons and in different sections of the country, depending to a large extent upon the conditions of the atmosphere. Unless, during the early growing season, it is possible to expose the chicks to direct sunlight from 10 to 30 minutes a day about two percent of a potent cod-liver oil or some other satisfactory fish-liver oil should be added to the otherwise adequate ration (400 units per pound of feed).

Laying and breeding flocks that are closely confined usually require a source of vitamin D, at least during the winter months. Ultraviolet light will not pass through ordinary window glass and when glass substitutes are used they should be kept free of dust, otherwise none of these light rays will penetrate to the birds.

The poultryman is cautioned against assuming that all grades or lots of cod-liver, sardine-liver, and other similar oils are equal in their vitamin D content. Aging, exposure to air, drying and other agencies may render even a good grade of oil valueless.

Vitamin D in sufficient quantity to prevent rickets or leg weakness in growing chicks has not been found in any natural poultry feeds, except whole milk from cows and egg yolks from hens, which have been exposed to direct rays of the sun. The usual method of supplying vitamin D is to expose the chicks to sunshine, in which case the vitamin D is developed in the body. If sunshine is not available a high-grade cod-liver oil or vitamin D powder will supply this necessary vitamin. (Fig. 4.)

**Riboflavin Deficiency.**—Riboflavin was first known as vitamin B<sub>2</sub> and later as vitamin G. It is required by all types of poultry.

12. In the diagnosis of D-avitaminosis care must be used to differentiate it from a condition known as slipped tendon (perosis). See page 34.

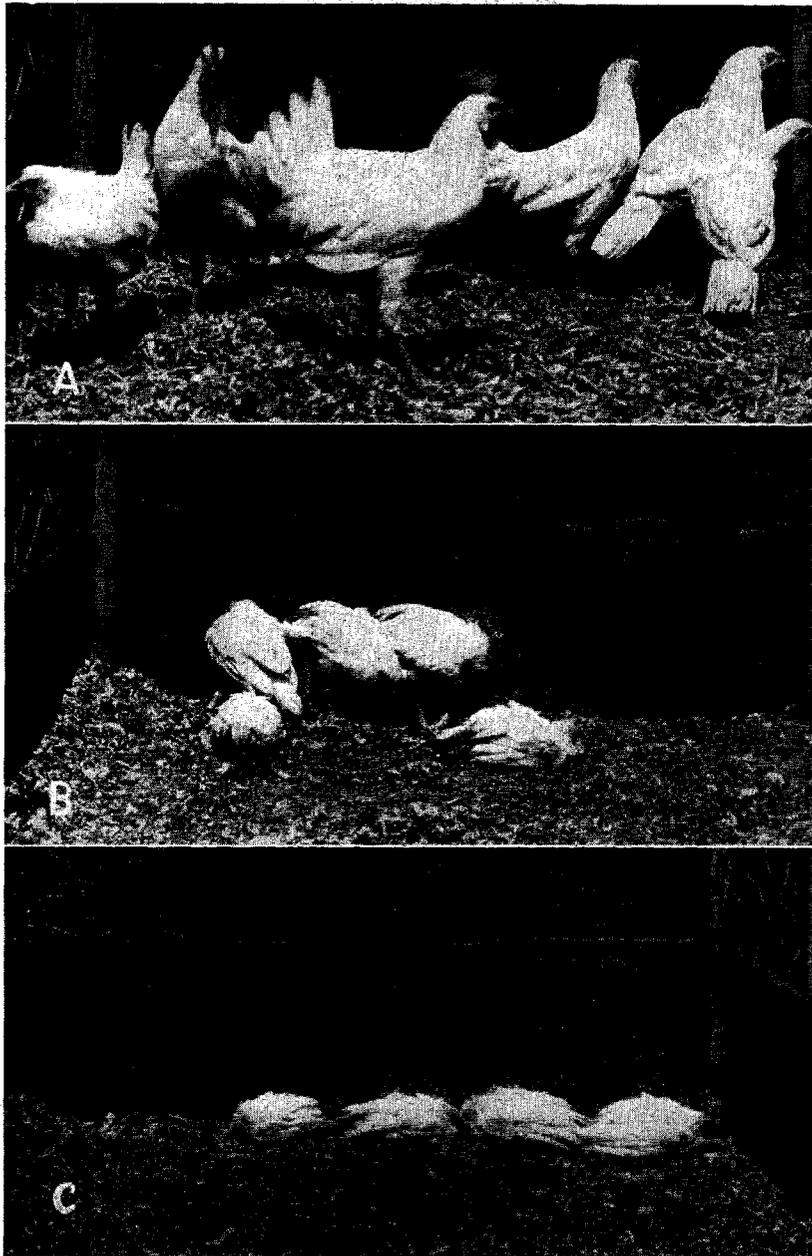


FIG. 4.—Groups of birds of the same age. Group A was given adequate diet and exposed to sunlight 30 minutes per day. Group B was given adequate diet but not exposed to sunlight. Group C was given adequate diet and exposed to sunlight through window glass—glass removes most of the ultraviolet rays.

When chicks are fed diets lacking riboflavin they grow slowly and become weak and emaciated. The chicks usually rest on their hocks with the toes curled inward. The leg muscles are atrophied. The wings droop and the skin is dry and harsh. Young chicks in advanced stages are unable to move about and they lie with their legs spread out. A post-mortem does not show any internal abnormalities.

In adult hens the only symptom of riboflavin deficiency is a decrease in productivity and hatchability. The hatchability improves rapidly when birds are fed adequate amounts of the vitamin. There is also an increase in size and fat content of the liver of such hens. The chicks hatching under these conditions are dwarfed and show a tendency to edema. The down is defective, and spoken of as "clubbed," due to the failure of the down feathers to grow out of the sheath. Curled toe paralysis, or curly toe, is prevented by an adequate supply of this vitamin.

Young turkeys show poor growth and an accumulation of scales and incrustations at the corner of the mouth and on the eyelids, with some dermatitis of feet and shanks. The nerves are known to be involved. There is degeneration of the myelin sheaths of the peripheral nerve trunks. This indicates that riboflavin is essential for the normal functioning of these nerves.

Riboflavin requirements decrease with the increased age of the bird, except that the requirement for laying hens is higher when hatchability is a factor.

Feed stuffs which can supply an adequate amount of this vitamin are dried yeast, dried whey, dried skim milk, and cottonseed meal. Wheat bran and yellow corn are relatively low. Young grasses and fresh or dehydrated, alfalfa offer adequate sources. Growing chicks require about 1,500 units of riboflavin per pound of feed.

**Thiamin Deficiency.**—Thiamin is also known as vitamin B1. The early studies on beriberi were made with polished rice. This led to considerable confusion, however, because it was lacking in other factors as well as the vitamin in question. The symptoms of thiamin deficiency are sometimes spoken of as polyneuritis. When birds are starved for thiamin they lose weight, the feathers become ruffled, and the legs weak. If the deficiency continues the legs become paralyzed and the head retracted. Such symptoms develop in three or four weeks on experimental diets. The symptoms are not so marked as in botulinus poisoning, or neurolymphomatosis.

The internal organs appear shrunken and in advanced cases there is fatty degeneration of the liver. In some birds the muscles appear darker than normal and there may be some edema. A part of these changes may be due to starvation.

Under farmyard conditions this deficiency should never occur since the vitamin is abundant in all grains, the leaves of many plants, in milk, yeasts and other ingredients which commonly go into poultry feeds.

**Pantothenic Acid Deficiency.**—Pantothenic acid is also a member of the old vitamin B complex. Chicks on diets lacking pantothenic acid are emaciated and develop a severe dermatitis. Scabs appear at the corners of the eyes and mouth, the margins of the eyelids are granular and are frequently stuck together by an exudate. In some birds the feathers are lost from the head, and there is a sloughing of the epithelial surface of the skin. The skin between the toes and the bottom of the feet cracks and sometimes peels off or develops thickened wartlike areas.

The liver in well advanced cases is enlarged and may vary in color from a faint yellow to a dirty yellow. The spleen is atrophied and the kidneys somewhat enlarged.

Young grass, alfalfa, liver, yeast, cane molasses, peanut meal, dried whey and dried milk are good sources of this vitamin. Wheat, corn and cottonseed meal are not such good sources as the above.

**Antigizzard Erosion Factor.**—Gizzard erosion was first detected in experiments dealing with vitamin K and was at one time believed to be due to vitamin K deficiency. The exact nature of the vitamin is not known at the present time, although a number of substances are known which will supply it.

The horny layer of the gizzard shows areas of degeneration. The degeneration is usually preceded by hemorrhages of varying size which occur most commonly on the cardiac end of the gizzard but may occur at any place. The lining becomes eroded and loosened from the underlying tissue. The areas become brown, or black, in color and have a frayed appearance. Since a large number of day-old chicks show this condition it is believed that it is due to some deficiency in the diet of the hen. Most chicks recover and the lesions disappear at the age of 5 to 8 weeks without adding any curative agents to the feed.

The curative factor is present in wheat bran, oats, whole wheat and barley. Bile acids also exert a curative action.

**Vitamin E Deficiency.**—This condition has been reported from numerous experimental laboratories but is probably of little importance on the farm. It has been discovered that there is a factor in cod-liver oil which hinders the use of vitamin E by chicks. This may result in the development of encephalomalacia in chicks which otherwise seem to be receiving a normal diet.

The same diet causes myopathy (a disease of the muscles) in ducklings and of the gizzard of the turkey.

Although vitamin E is not essential for egg production it is necessary for embryonic development. Embryos from hens lacking vitamin E die on or before the fourth day of incubation. In chicks killed soon after the symptoms develop the cerebellum is softened, swollen and the meninges are edematous. Minute hemorrhages are sometimes visible on the surface. These areas vary greatly in size and are of a greenish-yellow opaque appearance. In the cerebrum the necrotic tissues are pale, swollen and edematous. The areas are sometimes very extensive but at other times microscopic in size.

The chicks appear droopy. This is followed by a nervous derangement and periods of excitement develop suddenly with loss of power to coordinate muscular movements. There may be retraction of the head with lateral or twisting movements followed by complete prostration and death. There is no complete paralysis of legs or wings. This condition usually develops between the fifteenth and thirtieth day but may occur as early as the seventh, or as late as the fifty-sixth day after hatching.

In ducklings there is degeneration of the skeletal muscles in about the second or third week of the deficiency. This causes the birds to walk awkwardly with feet turned in, or they may sprawl on the floor. From this position they have difficulty in rising. There are occasional cases of tremors. The muscles are pale in color with edema and waxy degeneration.

In turkeys there is a degeneration of the muscles of the gizzard in which there develop gray areas of firm tissue. The muscle fibers in these areas are swollen and fragmented.

The condition largely can be prevented by use of cottonseed oil, peanut oil, wheat germ oil, which contains alpha-tocopherol, the ingredient which acts as vitamin E.

**Vitamin K** deficiency is not observed in chickens on well balanced feeds. The vitamin is present in leafy plants, dehydrated alfalfa, cereal plants and other grasses.

**Vitamin C**, or ascorbic acid, deficiency is not observed in chickens although it is very important in certain animals and man, in which it produces scurvy. This is probably due to the fact that the body of birds, or bacteria in the intestine, can synthesize this vitamin.

**Vitamin H** deficiency appears when chicks are about three weeks of age. The chicks cease to grow and the bottoms of the feet become rough and calloused. The fissures in the skin become hemorrhagic. The tops of the toes and feet may develop necrotic areas. Encrustations appear at the corner of the mouth and the eyelids are swollen and adherent.

Yeast, beef-liver and milk contain the vitamin. As a rule this condition does not develop in well nourished chickens.

There are a few other abnormal conditions which develop in birds which are not due to lack of vitamins. Gout is one such disease which is occasionally described but about which there is little accurate information. This is considered as a type of uremic poisoning characterized by internal deposits of urates. It occurs primarily in mature birds due to feeding of excessive amounts of protein concentrates, lack of green feed and sometimes, perhaps, to individual susceptibility. The symptoms are chronic and there may be enlargement of the joints and lameness. The swellings are soft and painful at first and later become hard and painful. The swellings may become permanent. There may be a deposit of urates in the viscera, the kidneys become enlarged, pale in color and the ureters distended with urates. It has been suggested that certain types of bumblefoot may be one form of gout. This may be con-

fused with infection of the joint area, or with vitamin A deficiency. A differential diagnosis without considerable laboratory study would be difficult.

**Other Feed Deficiencies.**—Although several writers have reported that lack of vitamins may lead to nervous disorders and diseases of the blood there is considerable evidence to show that other factors are the chief causes of these conditions. Further investigations will be necessary to solve these problems.

Numerous disease conditions have been reported, especially in birds on experimental feeds. In most of these experiments the deficiencies are extreme and are not parallel to those of a poultry flock under range conditions. Space does not permit a complete discussion of all of them. We have discussed diseases which appear to be of considerable importance to the poultryman. No doubt further experimental studies will place us in position for a more complete discussion later.

**“Crazy-chick” Disease.**—A condition occasionally develops in chicks three to four weeks of age which is manifested by muscular incoordination. They may become completely helpless, fall when attempting to walk, walk in circles, or exhibit trembling of the head and legs. The kidneys are swollen and congested and the blood contains an excessive amount of uric acid. Ducklings exhibit muscular degeneration. The condition is apparently due to a lack of certain water soluble factors. Placing the birds on a simple grain ration for a few days will usually check the trouble. After this the regular ration may be resumed.

**Water** is one ingredient which is absolutely essential to satisfactory growth. The physiological activity of the bird is higher than that of most animals. This results in the production of much heat which must be carried to the surface of the body by water. Water is essential for dissolving food products and aiding digestion. The influence of the quality of the water has not been studied except in regard to the transmission of infectious agents. Birds apparently do not object to filthy water and in some instances seem to prefer it. Although it has not been demonstrated, the fact that such water may adversely affect man and other forms of livestock there is reason to believe that filthy water may injure chickens and other birds. The addition of chemical disinfectants to dirty water is of no value in preventing the spread of the disease since the chemical combines with the filth and is not then available for destroying the bacteria. It is necessary to change the water at frequent intervals, at least three times a day.

**Mineral Elements** of various types are necessary in a properly balanced diet. Most minerals are supplied in sufficient amounts and in the proper ratios in most common feeds.

**Calcium** is an exception due to the excessive demands made to supply a sufficient amount for egg shells. The normal calcium-phosphorus ratio in the blood is about 2:1. This ratio is also very

important for the proper utilization of vitamin D. The ratio of the laying hen should be about 3:1. During heavy egg production this ratio is upset unless the bird is given an excess of calcium. This is usually supplied in the form of oyster shell or ground limestone. Oyster shell is very pure and is palatable to the chickens. Limestone is a good source of calcium and is a satisfactory source if it does not contain excessive amounts of harmful ingredients such as magnesium sulphate, which acts as a severe laxative and intestinal irritant.



FIG. 5.—Perosis or slipped tendon is due to feeding mash with too little manganese. (Note slipped tendon of right leg.)

*Manganese* has recently been found to play a very important role in poultry nutrition. It has been proved to prevent a condition known as perosis, or “(slipped tendon.” In perosis, the tendon which passes over the back of the hock joint, slips out of its condyle, the bird is then unable to support the weight of the body and the leg soon becomes permanently deformed. This condition may develop in birds of almost any age up to maturity. In addition there may be a crooked breast bone. (Fig. 5.) The use of the term “perosis,” to describe the condition, was unfortunate since the word is derived from a Greek word meaning maimed and is not descriptive of this particular abnormality.

The condition should be differentiated from rickets. In rickets the

bones are soft and there is beading of the ribs, while with slipped tendon the bones are of normal consistency. The latter is not prevented by exposing birds to sunlight or by feeding cod-liver oil.

Recent studies have shown that the feeding of ground oats instead of corn will largely eliminate slipped tendon. This may be due to the fact that the oats contain much more manganese than the corn. Miller and Bearnse<sup>13</sup> have reported that the manganese content of grains is as follows in milligrams per 100 grams of grain: Oats 4.66, wheat 2.91, barley 1.19, corn 0.38 mg. These data would indicate a marked deficiency in the corn and probably explains the prevalence of cannibalism and slipped tendon in birds on mash feeds containing large amounts of corn. For this reason it is recommended that part of the corn be replaced by oats. However, there is a limit to the amount of oats which can be fed, especially to chicks, because of the danger of impaction. It will be necessary for the practical feeder to determine the proper mixture for himself. The proper amount of manganese is furnished by adding 8 ounces of manganese sulfate per ton of mash.

### DISEASES OF POULTRY NOT DUE TO DEFICIENT DIET

Numerous important diseases of poultry are not due to deficient diet but to the action of microorganisms, higher parasites, or to some other factor. However, mild or severe dietary deficiencies often result in greater susceptibility and heavier losses from parasitic and infectious diseases. In the following discussion of diseases those due to similar factors have been classed together as far as possible. The first groups include those due to bacteria and viruses, the etiology of which is fairly well known. Following this are discussed diseases due to higher forms of life, such as molds, protozoa, worms, lice, and mites. The group last discussed consists of miscellaneous diseases and conditions which are of unknown etiology or not due to parasites.

### DISEASES DUE TO VIRUSES

The so-called "filterable" or "filter-passing viruses" cause a number of very serious diseases in birds. Among the more important are infectious laryngotracheitis, fowl pox, and leucosis.

The exact nature of the viruses is unknown. To date they have not been grown in the absence of living cells and they are too small to be seen even with the high-powered microscope.

The different viruses are recognized only by the various changes which they bring about in the body of the infected bird.

The viruses are fairly resistant to natural exposure outside the animal body and are extremely infectious for all susceptible individuals. Although the use of living-virus vaccines give a satisfactory immunity against some of the virus diseases, no product containing only dead virus material appears to be of much value.

13. Miller, M. W., and Bearnse, G. E. The cannibalism preventing properties of oats. *Poultry Sci.*, 16:314-321. 1937.

There are three diseases of the respiratory tract which are commonly confused. These are infectious laryngotracheitis, infectious bronchitis and fowl coryza. In 1937, a special committee on poultry diseases of the American Veterinary Medical Association suggested that these be differentiated and described as separate diseases. Infectious laryngotracheitis and infectious bronchitis are caused by viruses, while the fowl coryza is due to a bacterium. Laryngotracheitis appears to be most common in young adults, while infectious bronchitis is commonly a disease of chicks. Fowl coryza affects birds of all ages.

**Infectious Laryngotracheitis.**—This disease has been given different names, such as “Canadian flu” and “tracheolaryngitis,” and is often confused with fowl coryza and fowl pest. The name “laryngotracheitis” has been selected to describe this disease, because the early and more characteristic symptoms seem to be a severe inflammation of the larynx and trachea (windpipe). The disease is most severe in feeding stations and markets. Birds of all ages are susceptible, but losses are heaviest in young adults. Only chickens and pheasants are susceptible.

#### Symptoms

The disease is of sudden onset and spreads rapidly. The mortality rate is variable, but egg production is greatly reduced. Some birds make a complete recovery while others become carriers.

The disease is sometimes confused with infectious bronchitis and avian pneumoencephalitis, except that these diseases usually occur in much younger birds. Also the symptoms of these diseases in older birds are usually very mild. Sometimes cross vaccination tests are necessary to obtain a final diagnosis.

The first symptoms noticed will be excessive secretions of the eyes and nostrils and stretching of the neck and gasping, showing difficulty in breathing. (Fig. 6.) The nostrils are partly filled with dried mucus. With each inhalation the head is thrust forward, the beak is opened and the intake of air is accompanied by a loud wheezing sound. Coughing is frequent and a bloody exudate may be forced out of the trachea.

There is no swelling of the sinuses of the head and no diphtheritic patches in the mouth. The temperature is usually raised.

Autopsy shows few lesions except a slight enteritis and a severe laryngotracheitis. The trachea is partly filled with pus, sometimes mixed with blood. The wall of the trachea may show intense inflammation and hemorrhage. In many cases death appears to be due to a plugging of the trachea with a mass of cheesy material. The lungs may be normal or show areas of congestion. In some cases the lining of the proventriculus shows intense hemorrhage as described for fowl pest.

Young birds appear to be most susceptible and those most heavily parasitized with worms suffer heaviest losses.

The cause of the disease is a filter-passing virus, although various

organisms have been considered as factors contributing an early death. From many cases at this station the organism of fowl cholera has been isolated and other workers consider other organisms as significant.

**Control**

There is no treatment which is very effective in curing the sick birds. The spread of the disease may be prevented by carefully culling all birds before they are placed in feeding pens; careful sanitation and daily removal of droppings; removal of intestinal worms; protecting birds from cold and drafts; and killing the birds as soon as they begin to show signs of disease. Birds which have been killed



FIG. 6.—Laryngotracheitis—(gasping symptoms).

and dressed while suffering from the disease often show a bluish discoloration of the skin. Such birds should not be sold for food.

As death is often due to stoppage or occlusion of the windpipe or bronchi, any measures that will tend to prevent this condition will decrease losses. Hart recommends the use of "Fifteen grains of equal parts of ammonium chloride and ammonium carbonate given in capsule once or twice daily as an expectorant to assist in the elimination of the exudate. . . . Though not so satisfactory, the ammonium compounds may be given in a small amount of wet mash at the rate of 1 ounce to 25 or 30 birds as a flock treatment. Spraying the upper respiratory passage with a hypochlorite solution by means of an atomizer is also beneficial in individual treatment of valuable birds"<sup>14</sup>

14. D. Hart. *Everday problems of the poultryman*. State Inst. of Applied Agr. Bul. 118 pages. Ill. 84, 1927. (Farmingdale, Long Island, N. Y.) Ref. Section, Diseases and parasites.

Losses of live birds in transit are heavy. This is partly due to the methods of handling them. They are crowded into trucks or cars and become very much overheated while the vehicles are not in motion. Then the very rapid movement creates heavy drafts, the birds are rapidly chilled and rendered susceptible to any sort of infection which may be present. This may be corrected by improved methods of transportation.

In feeding stations the residual feed in the troughs is gathered and fed again. This is a sure method of spreading any disease of the head or respiratory system. Such feed should be discarded and the feeding troughs scalded thoroughly each time after use. Birds in feeding stations should be protected from drafts of cold air and winter winds. The feeding of soda in the drinking water has not proved to be of value in preventing or curing this disease.

Outbreaks of infectious laryngotracheitis are very successfully prevented by means of a living virus used as a vaccine. When introduced into the upper wall of the cloaca, the virus develops in the mucus membrane and results in a general immunity so that subsequent infection of the lining of the trachea is prevented. The vaccine has no curative value and its use must be considered only as a preventive measure.

The virus used for this purpose should be highly potent. It is usually sent into the field in a dry form and suspended in some liquid just before use. Care should be exercised not to contaminate the hands with the virus. Exposure to direct sunlight destroys the virus in a short time and renders it useless as a vaccine.

To apply the vaccine the bird is held with the tail uppermost. The tail feathers are smoothed back to expose the vent. The operator places the thumb and first finger on either side of the vent and by drawing apart and back the upper part of the vent is opened, thus exposing the mucous lining of the upper cloaca. The vaccine is introduced by means of a stiff brush or swab and carefully rubbed against the membranes four or five times with moderate pressure. The membrane should be somewhat injured but not made to bleed by too much rubbing. The surrounding skin and feathers should be carefully protected against contamination with the virus. The brush or swab should be dipped in the vaccine before each application. All remaining vaccine, brushes and other equipment used in vaccination should be burned as soon as the work is completed. This vaccine should not be introduced into flocks in which there has been no past infection. Heavily parasitized birds should not be vaccinated. New birds introduced into a vaccinated flock should be vaccinated.

The vaccine should be used on all farms where the disease has developed the previous season, or in those areas in which the disease is known to be endemic.

It is most satisfactory to vaccinate between the ages of six to twelve weeks and all birds in the flock should be treated at the same time. After vaccination the birds should be fed carefully and provided with an abundance of clean water.

From three to five days following a successful vaccination there is a marked inflammation of the mucosa of the upper wall of the cloaca at the point of inoculation. The mucous membranes are red, somewhat swollen, and covered with more or less mucus. The external park surrounding the vent are often swollen so that it is easy to detect a fullness of the tissues.

Immunity is well established in about nine days and persists for months, and probably for life, depending on the potency of the virus used in the vaccination. Sanitation is of great importance in the control of this disease.

**Infectious Bronchitis.**— This is a virus disease which is immunologically distinct from infectious laryngotracheitis. This means that birds which are immune to one disease may contract the other. The disease was first described in baby chicks by Schalk and Hawn.<sup>15</sup> It became popularly known as chick bronchitis or gasping disease.

#### Symptoms

Symptoms may appear within a day or two after hatching. Gasping and suffocation are most pronounced. In the more advanced cases the wings sag, the feathers become ruffled, the chicks become progressively weaker, and huddle under the brooder. At certain times the chicks emit a hoarse chirp during the gasping period.

Beach and Schalm<sup>16</sup> reported that nasal passage involvement occurred in more than half of the chicks artificially infected by the intratracheal route. They also found that birds from 10 to 112 days were equally susceptible to artificial inoculation. The disease spreads rapidly. The mortality is usually quite low but growth is retarded. The lungs are congested and the bronchi contain considerable exudate and yellow plugs. In some birds the air sacs and even the head may be involved, although it is by no means certain that the last symptom is not due to the action of the organism causing fowl coryza. The upper trachea is rarely affected. This would distinguish the disease from laryngotracheitis.

This disease in adults is comparatively mild although egg production is seriously checked. The post-mortem examination reveals inflammation of the parts affected. This may be followed by an invasion of the head and lungs by several secondary invaders as is observed in A-avitaminosis. Some birds which recover become carriers of the virus.

#### Control

Numerous outbreaks of this disease have been traced to "started chicks" in hatcheries.

At present there is some dispute about the immunity which results from recovery or vaccination, but writers generally agree that when

15. Schalk, A. F., and Hawn, M. C. 1930. An apparently new respiratory disease of chicks. Proc. Thirty-fourth meeting of the U. S. Livestock Sanitary Assoc. pp. 413-422.

16. Beach, J. R., and Schalm, O. W. 1936. A filterable virus distinct from that of laryngotracheitis, the cause of a respiratory disease of chicks. Poultry Sci. 15:199.

the disease appears in a flock a vaccine may be prepared from the sick birds and used on the remainder of the flock in the same manner as the laryngotracheitis virus.

As in the case of any other infection, sanitation and care of the flock will do a great deal toward reducing the losses. The precautions given under tracheitis will likewise apply here. No effective treatment has been found. When this disease develops in a hatchery or brooder room it may be necessary to remove all chicks and introduce careful sanitary measures.

**Fowl Pest.**—This disease is frequently called “fowl plague” and “bird plague.” It is an acute, infectious disease of most domesticated birds due to a filter-passing virus.

Fortunately this disease is not now present in North America. Several outbreaks have occurred, but vigorous action on the part of the U. S. Bureau of Animal Industry has checked them in the early stages.

#### Symptoms

The symptoms are not especially characteristic and the disease is frequently confused with fowl cholera, fowl typhoid, or laryngotracheitis. There is usually great prostration and rapid death. Some birds exhibit convulsions, and diarrhea is common. The bird sits with closed eyes and ruffled feathers. The head and neck are frequently swollen and the comb cyanotic (bluish). Temperatures are usually very high.

Onpost-mortem the lungs are found to be congested, and there are small hemorrhages on the membranes of the heart similar to those observed in cholera. Other organs exhibit the hemorrhagic condition. The lining of the proventriculus is congested and often there are catarrhal and hemorrhagic areas on the tips of the glands.

Edema of the glottis may develop, followed by difficult respiration. A mucous exudate may collect in the pharynx and nostrils.

#### Control

At present the only method of controlling this disease is the destruction of all the birds in an infected flock, followed by careful sanitary measures. Whenever such a disease exists in a community special efforts should be made to avoid spreading the virus to other flocks. Outbreaks should be reported to livestock sanitary authorities immediately and all traffic in poultry in the community must be suspended.

All houses should be treated with lye solution or coal-tar disinfectants. The runs must be plowed or spaded several times to expose the soil to the action of sunlight.

**Pseudo Plague.**—Other names for this disease are “Newcastle Disease” and “Ranikhet Disease.” This disease has been reported from various parts of the world but is not recognized as of importance in this country at present. The symptoms are similar to those of fowl plague. It is due to a filter-passing virus.

**Symptoms**

The incubation period is longer than in fowl plague, the diarrhea is more pronounced and the gasping inhalations more common (present in 70 percent of the cases). There is lameness or paralysis in one or both legs. In the field it will be difficult to differentiate this disease from fowl plague and fowl cholera.

**Control**

The control is the same as for fowl plague.

**Leucosis.**—Leucosis is a term used to characterize a group of disease conditions which are not well defined. Writers are not agreed on the cause, although several have been able to produce the various types by means of a virus.

Leucosis is the most destructive disease in Kansas. It has spread slowly during the past few years until it is now found in all sections of the state. Birds of all ages may be affected, but the heaviest losses are in those from four to six months of age.

Many writers believe that some predisposing factor is necessary before the virus can invade the body. Apparently a variety of parasites are important in this connection. These include the various types of coccidia, microscopic tapeworms, and certain bacteria of the *Salmonella aertrycke* group. At present it is not possible to state definitely just how important they may be. There is considerable experimental evidence that an hereditary factor is involved in resistance. It is also possible that lack of vitamins and growth factors may play an important role although information to prove this point is inadequate.

The diseases appear to be widespread on the American and European continents, appearing each year in the same flocks. All breeds are affected. Mortality may range as high as 60 percent. The method of transmission is not known but there is evidence that it is transmitted from the hen to the chick through the egg.

**Symptoms**

The nomenclature used to describe the avian leucosis complex was arranged by a committee of pathologists, coöperating with the United States Regional Poultry Research Laboratory at East Lansing, Michigan, in 1941. The terms used are listed below.

- 1. Lymphomatosis..... Lympholeukosis
- (1) Neural ..... Range paralysis
- (2) Ocular ..... Pearly eye, glass eye
- (3) Visceral ..... Big liver disease
- (4) Osteopetrotic ..... Marble bone
- 2. .... Erythroblastosis ..... Erythroleukosis
- 3. .... Granuloblastosis ..... Myeloleukosis
- 4. .... Myelocytomatosis .....

This scheme does not imply a classification on an etiological basis.

The neural, ocular and osteopetrotic types of lymphomatosis may be diagnosed clinically, but the diagnosis of the other forms of the disease rests mostly on post-mortem findings.

The leucotic symptoms common to the various forms of the disease, which usually attacks maturing pullets and cockerels, are somewhat as follows: The comb is anaemic or yellowish and feels cold and lifeless; there is decreased appetite and the bird is listless; the temperature is about normal or somewhat subnormal; diarrhea with greenish-colored droppings is commonly observed. In advanced cases the bird may become blind and somewhat lame or partly or completely paralyzed. In some instances the bird is thin and pale and occasionally the bones become very much enlarged. This condition is known as "thick-leg disease," "marble bone," etc.



Fig. 7.—Typical case of neurolymphomatosis involving the left wing. (See Fig. 8.)

The symptoms of neuralymphomatosis are about as follows: Paralysis of one or both legs is the most common symptom, although loss of use of the neck or wings may be noted. (Fig. 7.) The symptoms are sudden in their onset. The birds appear healthy, then suddenly become lame in one or both legs or lose control of the wings or neck. This condition has been described as "range paralysis." This is followed by complete loss of use of the legs and the bird becomes rapidly emaciated, following loss of appetite. Sometimes the bird loses control of the neck and paralysis of the eye muscles develops. This may be followed by blindness. The duration of the disease varies from a few days to many weeks. As the disease becomes generalized the muscles of the affected member become atrophied and the bird exhibits general debility, emaciation, and often a diarrhea.



FIG. 8.—Illustrating the involvement of the nerve to the left wing. The nerve to the right wing is normal in size, that to the left wing is greatly enlarged by the infiltration of the tumorlike cells. (Nerve preparation from bird in figure 7.)

Many birds develop an ocular condition known as "glass eye" or "pearly eye" because of the peculiar bluish-gray color. In such cases some of the tissues of the eye are destroyed, the bird becomes blind and is unable to find food. The iris of one or both eyes loses its normal clear pigment and develops an irregularly diffuse bluish-gray color. The pupil becomes irregular and in advanced stages

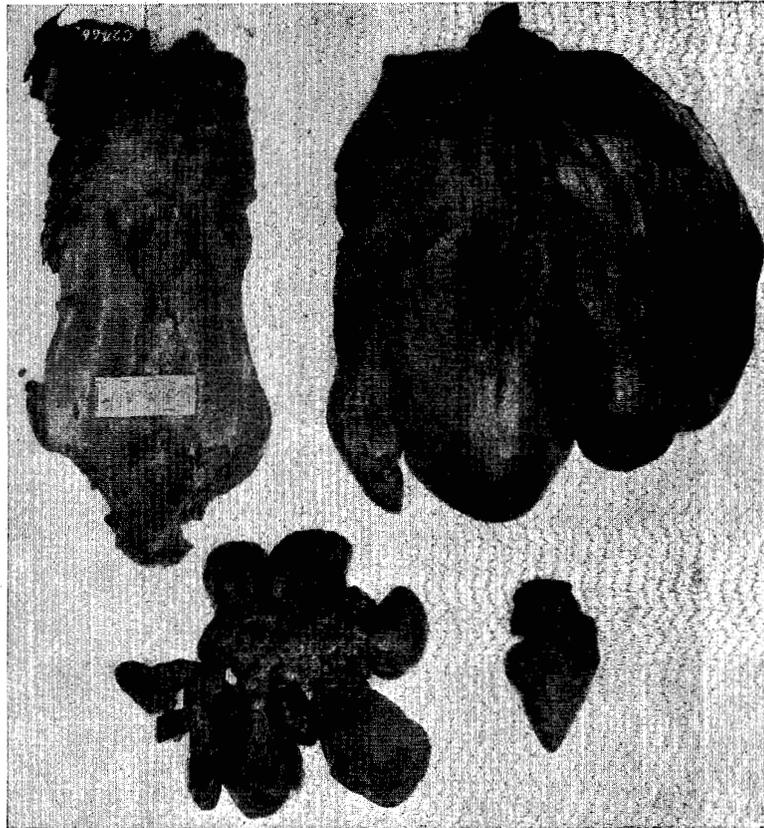


FIG. 9.—Leucosis. This figure illustrates a generalized tumorlike condition involving the breast muscles, liver, ovaries, and heart. Note the enormously enlarged liver.

may be reduced to a pin-point in size, and the power of accommodation to variation in light intensity is lost.

The visceral type of this complex has been described as "big liver disease." The comb is usually pale but may be darkened due to impairment of the circulation. Sometimes the bird becomes very much emaciated and it is possible to feel the enlarged liver.

There are usually a variety of pathological changes. The large abdominal organs are chiefly affected. The spleen and liver may

be two or three times normal size. The ovary may develop a mass of tumors. The heart and kidneys are frequently diseased and exhibit local tumorlike lesions. Multiple tumors may develop on the mesentery. In general the liver and spleen become much enlarged. (Fig. 9.) The color is usually altered to a pink, yellow, or mahogany. In some instances the surface is uniform in color, in others mottled, and sometimes there are firm tumorlike nodules throughout the organ. The kidneys may appear swollen and mottled; the heart flabby, with occasional hemorrhages and tumor masses; the lungs are usually pale. The blood appears pale and thin and if examined under the microscope shows a great increase in number of leucocytes (white blood cells) and a marked decrease in red cells. This accounts for the pale comb and mucous membranes.

A peculiar type of the lymphomatosis is the osteopetrosis, "thick-leg" or "marble bone disease." This is a comparatively rare type of the disease; all the long bones may be involved. There is thickening of the cortex and the bones become extremely hard. Anemia may result from a destruction of the bone marrow. This condition may be confused with D-avitaminosis and perosis.

The **Erythroblastosis**, sometimes spoken of as erytheoleukosis, was described by Ellermann and Bang in 1908. It is somewhat less common than other types and is chiefly observed in birds more than six months of age. The comb most frequently exhibits a yellowish color. As the disease progresses the bird develops progressive emaciation, loss of vigor and may develop a severe diarrhea. The post-mortem examination frequently reveals small hemorrhages on the various internal organs in small intestines and liver. The liver, spleen and kidneys may be greatly enlarged. The spleen is usually cherry-red in color. Separately formed tumors are absent. The marrow of the long bones, where the blood cells are formed, may become hemorrhagic. The liver and spleen are engorged with primitive blood cells of the erythroblastic series. The blood is pale, watery and clots slowly.

**Granuloblastosis** is not essentially different from erythroblastosis except in the type of cell involved. In the erythroblastosis the primitive red blood cell predominates while in the granuloblastosis the white blood cell is most prevalent. Both are primarily due to a disease of the bone marrow. The symptoms of the disease are not different from those of erythroblastosis except that the comb becomes pale instead of yellow. The liver, spleen and kidneys become enlarged and grayish instead of pink in color. These organs exhibit a massive accumulation of the primitive type of white blood cell. The bone marrow becomes grayish in color for this reason.

**Myelocytomatosis** has been described as an aleukemic tumorlike form of the disease. The symptoms are not characteristic. On post-mortem examination yellowish-white tumors are observed in the visceral organs and muscles and attached to the ribs. It would not be possible to differentiate this condition from that of other neoplasms as observed in the field.

### Control

This disease is difficult to control and the owner of a badly affected flock should dispose of all birds which appear to be sick. In many cases it is best to dispose of the entire flock, if too much disease is present.

As in the case of any other infectious disease the most effective control is improved sanitation, better feeding methods, and free range. For other suggestions regarding control the reader is referred to the discussion on hygiene and sanitation in this bulletin. In certain instances badly diseased flocks have recovered after being placed on screen wire or sanitary runs. No practical therapeutic measures have been developed. It is more practical to breed from two-year-old stock since these birds are more resistant than younger birds.

**Fowl Pox.**—Fowl pox is very common in many parts of this country and rather prevalent in Kansas. Usually the disease is not serious here, although this is not always the case, and heavy losses have been known to occur in this state. Fowl pox is also called "contagious epithelioma." The cause is filter-passing virus. There appear to be three varieties of the pox virus affecting birds. The fowl pox virus affecting chickens and turkeys, the pigeon pox virus and the canary pox virus. The disease is called "fowl pox" or "bird pox" from the appearance of the peculiar wartlike growths which appear on the skin, chiefly on the comb and wattles. (Fig. 10.) The virus must be brought into contact with an injured epithelium before infection takes place.

### Symptoms

The most characteristic symptom of bird pox is the development of small, smooth, grayish to white blisterlike eruptions which appear on the skin. These areas enlarge and later become covered by dry wrinkled crusts which vary in color from yellow to black. When these tumorlike structures are removed the underlying surface is raw and bleeding. In some cases there may be but a few of these lesions while in others the head is almost entirely covered. Associated with the development of these tumorlike growths on the skin, cankers may develop in the mouth and there may be an eye involvement.

Usually there are no well-developed constitutional symptoms in uncomplicated cases of fowl pox. There is no offensive odor unless there is involvement of the mouth or eye. Post-mortem lesions are not well marked. Very few birds show congestion of the lungs and other internal organs. There may be a few hemorrhages on the heart and in some cases there is pneumonia. If the lungs are affected the birds may cough out masses of yellow exudate that collect in the trachea and cause suffocation.

### Control

Sick birds should be isolated, kept warm, and fed plenty of green feed and sour milk. The scabs may be softened with glycerine or medicated vaseline and removed. The infected area thus left ex-

posed should be treated with a 5 percent silver nitrate solution or tincture of iodine.

A medicated vaseline may also be used to advantage for treating the early stages of fowl pox. (See appendix.) The houses and runs should be rid of lice and mites and sprayed with a disinfectant. The birds must be freed of worms.

A virus has been prepared that seems to be of considerable value for immunizing birds against this disease. It should be used soon

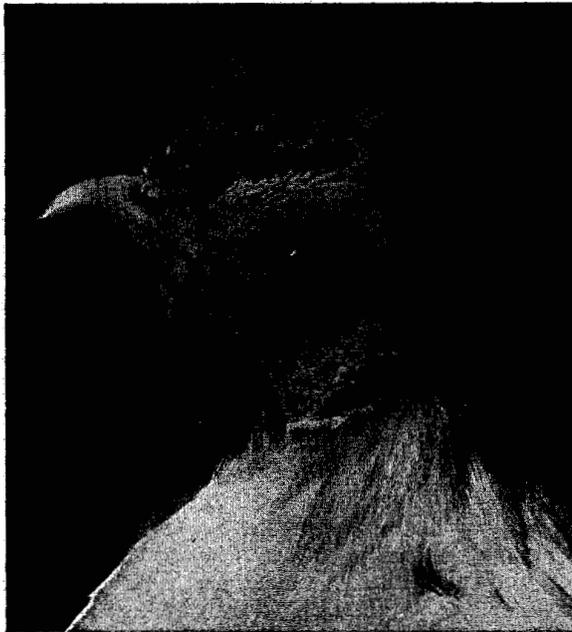


FIG. 10.—Head of pullet showing typical fowl pox eruptions.

after preparation as it does not long retain its potency unless kept at a low temperature. One treatment is sufficient. Two methods of vaccination in common use are the “stick” method and the “feather follicle” method.

Vaccination is to be recommended only in flocks where the disease has previously appeared. All young stock on the place should be vaccinated. Great care must be exercised to prevent dissemination of the infection to other premises by individuals who have handled the virus or diseased birds, by transfer of infected or recently vaccinated birds, and by contaminated material and equipment.

Good results cannot be expected if flocks are heavily infested with worms or other parasites, or if they are low in vitality due to other causes. Best results are obtained by vaccinating healthy, immature birds, preferably those two to three months of age.

The following steps should be carefully carried out in vaccinating by the "stick" method. A small sharp pointed knife blade is wrapped with adhesive tape leaving three-sixteenths of an inch of the tip exposed. A satisfactory instrument for vaccination may be made by inserting two needles into a cork so that the eyes are exposed. The powdered virus is suspended by placing it in the bottle of salt solution and shaking it vigorously for several minutes. Occasional shaking during use is necessary to prevent settling. A small amount of the material is poured into a glass vial or other container and a piece of cotton is placed in the bottom to protect the knife point when it is dipped into the virus before each inoculation. It is necessary to protect the vaccine from direct sunlight since it is destroyed in a few minutes if not covered.

The bird is caught and placed on its side on a table or box. (If several birds are caught and held at the same time they struggle less than if held alone.) A bare area of skin is located by brushing up the feathers outside and below the thigh joint of the leg. The knife point which has been dipped into the pox virus suspension is then thrust through the skin of this area. For birds three to four months of age two "sticks" are made, while older birds should receive only one. Younger birds may be given three sticks according to general conditions and development. The knife point should be dipped before each "stick" to insure takes. Young birds may be vaccinated in the wing web. In this case one "stick" is usually sufficient because the puncture penetrates through the web and "vaccinates" the skin in two places.

Birds may be vaccinated by the "feather follicle" method by removing three or four green feathers from the same area of the thigh and introducing the virus by means of a small stiff brush.

No general change in management or care is necessary, except that it is essential to protect the flock against any unfavorable conditions for three weeks after vaccination.

Ten to twelve days after vaccination a representative number of the birds should be caught and examined to determine if scabs have formed at the point of vaccination. If a majority of the birds do not show scab formation it indicates that the vaccination was improperly done, or that birds were naturally immune, or that the virus used had lost its potency. Under ordinary conditions where the percentage of takes is low, it is advisable to revaccinate. Reaction following vaccination usually occurs during the third week and after the scabs have formed and disappeared. Laying flocks usually show a marked continued drop in production, while worm-infested and weak birds may die following vaccination. In vigorous young birds kept under favorable conditions little difficulty and few losses are experienced.

Many investigators recommend the use of pigeon pox virus for laying flocks and heavily parasitized flocks. This virus is less injurious than the fowl pox virus. Although it yields a fair degree of protection it is not as satisfactory as the fowl pox virus. The pigeon pox virus should always be introduced by the feather follicle

method. According to reports from the California Experiment Station turkeys must be vaccinated twice each year. Young birds from 8 to 12 weeks of age may be vaccinated and all birds held as breeders should be vaccinated a second time six or seven months later. The upper thigh is the most suitable area for vaccination. The method of application on chickens is satisfactory with turkeys,

**Avian Pneumoencephalitis.**— This is a nervous disorder first described by J. R. Beach<sup>17</sup> in California. Outbreaks are accompanied by a respiratory disease similar to infectious bronchitis. The disease has been observed in pullets, hens and young turkeys. It is due to a filter-passing virus and cage and pen transmission can be accomplished artificially. This disease has not been recognized in Kansas.

#### Symptoms

In young chicks the symptoms are indistinguishable from infectious bronchitis but in a few days the birds develop nervous symptoms which persist for some time after the respiratory phase disappears. The nervous symptoms consist of a partial paralysis in one or both legs, incoördination, tremor and the chick may walk in circles. The appetite may or may not be impaired. Sometimes death is rapid. Although the average mortality is between 5 and 10 percent many of the survivors are unthrifty.

In older birds the disease spreads rapidly through the flock, egg production drops but the death losses may be quite low. Symptoms in birds of all ages are much the same.

The autopsy findings are not highly diagnostic. In chicks the air sacs are thickened and the trachea and bronchi may contain a yellowish, or clear mucous exudate. Submucous petechial or diffuse hemorrhages on various portions of the intestinal wall (particularly on preventriculus) have been reported. No lesions of the central nervous tissues have been described.

#### Control

To date no specific treatment has been developed. Beach suggests improving the feeding program by using more milk products, soaked grain and green feeds. Careful sanitation is of course necessary to prevent spread of the infection. Careful cleaning and disinfection should follow the removal of all sick birds.

**Avian Encephalomyelitis.**— This name was applied to a nervous condition of young chickens formerly known as epidemic tremor.<sup>18</sup> At present it appears to be localized in the New England area. Although this is primarily a disease of chickens between the ages of one to six weeks, turkey poults and ducklings are reported to be susceptible to inoculation.

The cause of the disease has been found to be a virus. The man-

17. Beach, J. R. 1940. A nervous disorder of young chicks. Nulaid News. 18:13.

18. Janes, E. E. 1934. Epidemic tremor, an encephalomyelitis affecting young chickens. Jour. Exp. Med. 59:781.

ner of distribution through a flock is not known but is probably due to contaminated surroundings. Insect transmission has not been demonstrated.

#### Symptoms

The diseased chickens are listless, dull and exhibit an unsteady gait. The incoördination becomes more pronounced as the disease develops. The chick may become so weak that it sits on its haunches and walks on its hocks. Trembling of the head and neck is observed in some birds. Death follows complete prostration within a few days with lesions in the brain.

It is difficult to differentiate this disease from rickets, and other nutritional disturbances.

#### Control

Since the disease is so sporadic it appears to be sound practice to dispose completely of badly affected flocks and not to restock until careful sanitary measures have been employed. The feeding practices should be carefully checked to eliminate all possibility of vitamin and mineral deficiencies. Parasitism should be controlled by methods described under other sections.

### DISEASES DUE TO BACTERIA

Among the important disease-producing agents are a group of single-celled organisms called bacteria. These organisms are large enough to be seen with the microscope and may be cultured in the laboratory. Although the bacterial diseases are among the earliest studied, little progress has been made toward means of cure once they have developed, and the poultryman must control losses by avoiding infection.

**Coryza (Colds).**—This condition has recently been called fowl coryza and is very difficult to differentiate from laryngotracheitis, since birds of about the same age are affected. In other instances it is no doubt confused with the so-called nutritional roup due to lack of vitamin A in the diet. The only means of differential diagnosis would be in the laboratory.

Coryza affects the fowls most commonly during the winter months, and young birds are more susceptible than mature birds. The chicken seems to be the most susceptible, but all types of poultry may suffer, although the pigeon is refractory. This disease, of itself, is not a serious menace to the flock, but may lead to severe forms of ophthalmia, or "roup." Usually but a few of the individuals of the flock suffer from this condition at a time, although in some flocks nearly all birds are affected.

An organism, *Hemophilus gallinarum*, which is capable of causing the acute type of "roup complex" with all the characteristics of that disease has been described, both in this country and in Europe, and is now recognized by many investigators as the cause. No doubt other forms of bacteria are involved in some outbreaks.

### Symptoms

Often the first symptom noticed by the poultryman is that bits of straw and feathers stick to the beak and nostrils. There is more or less sneezing and mouth breathing. The birds appear to be sluggish, the comb may be pale, and the feathers have an unthrifty appearance. If the birds are allowed to remain quiet and are watched carefully, affected birds will be seen to hold the head up and to gasp for breath because of the plugging of the nostrils by dried exudate. In many cases the eyes will be closed. Usually there is no foul odor connected with this disease, as is noted in cases of well-advanced nasal catarrh or canker. Other complications are sinusitis, tracheitis and bronchitis. In some outbreaks death rates are high and the disease has much the appearance of tracheitis. Even in flocks where the death rate is less severe there is loss due to decreased production.

### Control

The treatment for colds lies chiefly in removing the cause. The first birds to suffer are those of low vitality. Crowding, drafts, moist and poorly ventilated houses, insanitary conditions, lice and mites, worms, and inadequate feed will all tend to predispose birds to this disease.

As in colds in man, bacteriological findings are not uniform. Many organisms can be found in these conditions that may or may not be pathogenic for healthy birds. It is quite possible that under conditions to which fowls are exposed numerous organisms may assume a disease-producing power. No method has yet been devised for successfully vaccinating birds against this condition, and one attack does not lead to a solid immunity.

The chief factors which predispose birds to colds are drafts that strike the birds while at roost. Cracks, knot holes and crevices on opposite sides of the house will almost always lead to colds. It is essential that birds be given fresh air without drafts and be kept in clean, dry houses flooded with sunshine. This means that three sides of the house should be absolutely tight during the winter months, and the house so constructed that birds will not be reached by drafts of cold air from the fourth. A properly constructed open-front house is suitable. Such houses should have solid partitions at frequent intervals to prevent drafts. Equally as dangerous as drafts is lack of ventilation. The temperature of the bird is normally high, about 107°F.

The bird also eliminates large amounts of moisture from the lungs. This must be removed by ventilation. Cold, dry air is not dangerous since the bird is fairly well protected against all but extremes of cold.

During the daytime the birds must be made to work vigorously for their feed. This may be accomplished by compelling them to scratch for grain in deep litter. Exercise will keep up the temperature, increase vigor, and prevent overeating, the development of sluggish conditions, and cannibalism.

The first steps to be taken when colds appear in a flock are to free the house and birds of lice and mites, to examine the intestinal contents of some slaughtered birds for worms, and to see that the birds have a place to roost that is dry and free from drafts. In most cases sick birds will recover more rapidly if placed in small cages so they cannot exercise and can be kept warm. Birds should be given a dose of Epsom salt at the rate of one pound per 100 adult birds. Affected birds should be removed from the flock and the nostrils treated with a two percent potassium permanganate solution, or a ten percent watery solution of baking soda.<sup>19</sup> This should be forced into the eyes, mouth, and nostrils by means of a medicine dropper, or a feather dipped in the solution. In some cases it is easier to submerge the bird's head in the solution for 20 to 30 seconds. See that the nostrils are opened and well irrigated with one of these solutions at least twice each day until recovery.

Van Es and Olney<sup>20</sup> recommend the alternate use of a 4 percent solution of boric acid and a mixture composed of 5 grains of carbolic acid, 10 grains of menthol, and 1 ounce of liquid petrolatum, injected into the nasal passage two or three times a day as long as a nasal discharge is present. Delaplane and Stuart<sup>21</sup> found that 1 percent of sulfathiazol, given in the feed, was of value in treating coryza. No doubt some of the other sulfa drugs could be successfully used for treating this disease.

It should be kept in mind that a cold is probably a contagious disease and may be transmitted from one bird to another through feed hoppers and drinking fountains. For this reason sick birds should be removed from the flock as soon as discovered, and not returned. To remove any birds with symptoms careful culling several times each day should be practiced.

Since the drinking fountains are the most important factor in the dissemination of diseases of the head, they should receive special consideration. Scalding these vessels twice each day is of value. The addition of certain commercial chlorine compounds, as recommended; or one level teaspoonful potassium permanganate in five gallons of water, are effective antiseptics and reduce the spread of infection. It is necessary to renew either of the above compounds at frequent intervals, and to keep them before the birds all the time the disease is in progress. Running water to replace drinking fountains in the poultry house, when it can be installed without too much expense, appears to be effective in reducing the spread of all infectious diseases, especially colds and laryngotracheitis.

**Catarrh (Nasal Roup).**—Catarrh is very similar to coryza, but is characterized by a more chronic course and greater difficulty of control. It usually follows a cold that has not been properly treated,

19. See appendix for instructions for the preparation of percentage solutions.

20. Van Es, L., and Olney, J. F. Diseases of Poultry—their nature and control. Neb. Agr. Expt. Sta. Bul. 290, p. 110. Fig. 30. 1934.

21. Delaplane, J. P., and Stuart, H. O. The Chemo-therapeutic value of sulfathiazol in preventing and treating infectious coryza (*Hemophilus gallinarum*) infection in chickens. J. A. V. M. A. 99:46. 1941.

The cause is not known, but probably many types of bacteria are active as described for fowl coryza. The *H. gallinarum* is usually not found in this disease.

#### Symptoms

The symptoms are those seen in coryza, but are more serious and tend to persist for long periods of time. This condition may become chronic and a cure impossible. The nostrils are plugged with dried mucus and mouth breathing is a characteristic symptom. This leads to drying of the mucous membrane of the mouth and tongue, resulting in a disease sometimes called "pip." An offensive odor develops in some cases. This will depend upon the type of secondary invaders present.

#### Control

The treatment is the same as that described under coryza. Sick birds should be isolated into separate small cages, kept warm, and fed carefully. The nostrils should be cleaned out twice daily with a 2 percent solution of potassium permanganate, or 10 percent solution of baking soda.

All insanitary and unhygienic conditions must be corrected. The healthy birds must be freed from worms, lice, and mites and given an adequate diet containing some such feed as sprouted oats or green alfalfa. Potassium permanganate should be kept in the drinking water until the trouble disappears. This will aid in preventing the spread of the disease to well birds.

**Canker (Avian Diphtheria).**—Canker is a very serious disease of all types of poultry, but more especially of the chicken. The disease appears to develop rapidly in severity when once introduced into the flock. Many outbreaks appear to be associated with fowl pox and this may be one form of pox. The common type is also called "diphtheritic roup" and "fowl diphtheria." It is difficult to classify diseases affecting the head of the bird because the causative factor is not known and bacteriological findings to date have been contradictory. However, some of the most serious outbreaks of these diseases seem to be closely associated with *Pasteurella avicida*, the organism causing chicken cholera, and *Hemophilus gallinarum*, the organism chiefly involved in fowl coryza.

Some authorities consider that canker is caused by a filter-passing virus, and that the bacteria present are merely secondary invaders. However, in those outbreaks associated with *P. avicida* the losses are usually heavy and the disease is very difficult to control. No doubt a variety of pathogenic organisms may be involved under different conditions.

#### Symptoms

Canker is characterized by the development of diphtheritic patches in the mouth and throat. These may be few in number and small, or so numerous and large as to cover nearly the entire mucous membrane of the mouth and tongue. The lesions are covered by a yellowish membrane that is removed with difficulty, leaving a raw

surface. In many cases this stage of the disease is characterized by a very offensive odor due to the invasion of putrefactive bacteria.

The birds may show symptoms of catarrh, wartlike growths on the skin, or ocular and nasal sinus troubles. Mouth breathing is also a characteristic in many cases. The birds appear pale, show lack of appetite, and are unthrifty in appearance. The mucous membranes of the mouth show the diphtheritic patches and are usually thickened and reddened. There are occasionally symptoms of pneumonia, whitish diarrhea, with high temperature and excessive thirst. Some authorities consider vent gleet as one form of canker, as it is commonly found in the same flock. The lack of constant bacteriological findings makes a classification of these diseases difficult.

#### Post-mortem Findings

Birds dead of canker show a variety of lesions. Aside from the diphtheritic patches in the mouth, throat, larynx and occasionally the trachea, there may be a thickening and inflammation of the wall of the intestine, with ulcerations. The liver may be enlarged and pale, with yellowish areas on the surface. The lungs are usually not affected, but may show inflammation. Birds suffering from these conditions may show an excessive number of ruptured egg yolks and lesions of the heart and joints.

#### Control

Sick birds should be placed by themselves and given individual treatment. The houses and runs must be carefully cleaned and disinfected. Mites, lice and worms predispose to canker and care must be exercised to free the birds and houses of all parasites. This disease does not respond readily to treatment, and unless the birds are valuable it is best to kill them if they are badly affected. Some cases may be treated successfully by removing the membrane from the surface of the lesions with a bent wire or hairpin and painting the raw area with a 10 percent solution of argyrol or tincture of iodine. A 5 percent solution of silver nitrate is effective, but is also very irritating and should be used with care. Potassium permanganate in the drinking water will aid in preventing the spread of this infection.

If the disease once appears, all precautions must be exercised to control its spread. Great care should be exercised not to introduce the disease with newly purchased birds, or birds that have been exhibited at shows. Prevention is much more effective than attempts to cure sick birds.

**Ophthalmia (Ocular Roup).**—The most outstanding form of disease of the head under the old classification of roup is ophthalmia. It is a disease affecting the eye and surrounding tissues. As in case of the other affections of the head of the bird, the cause is somewhat in doubt. Certain types of ophthalmia may be merely another manifestation of pox or canker, but this is not definitely known. Some

of the most severe outbreaks of the disease appear to be closely associated with the organisms causing fowl cholera and fowl coryza. In other cases the cause is an eye worm or perhaps injury. The lack of vitamin A likewise leads to a very pronounced type of eye lesion.

**Symptoms**

Ophthalmia is characterized by its chronic course, rather light losses, the characteristic bulging of the eye, and the offensive odor associated with the later stages of the disease. The first symptom is that of a common cold. There is a slight watery discharge from the nostrils and eyes. This discharge in the early stages of the disease is generally characterized as "foaming." If the disease progresses, the discharge dries in the nostrils, the eyelids become glued together, and the exudate beneath the lids causes the eye to swell. The swelling may attain the size of a hickory nut. When the lids are pulled apart a tough, yellow, cheesy mass protrudes. This stage is often called "swellhead" or "ocular roup." This stage is also associated with the offensive odor so characteristic of the disease. The sinuses (spaces) about the eye may also become affected and cause marked swelling of the tissues. In some cases the sinuses alone are affected.



FIG. 11.—Typical cases of ophthalmia (ocular roup). (A) Severe chick case. This is a highly infectious form of the disease. (B) Typical case in an adult hen.

### Control

Sick birds should be placed in isolation pens, and the eye freed from all exudate. If the sinuses are affected they should be opened with a sharp knife. The conjunctiva or the sinuses should be treated with hydrogen peroxide to cleanse thoroughly. In stubborn cases a 5 percent solution of silver nitrate, a 2.5 percent solution of lysol, or a 10 percent solution of argyrol may be used.

Birds that have suffered from a severe case of ophthalmia (Fig. 11) are usually of little value and should be destroyed or fattened for the market as soon as possible after recovery.

**Infectious Sinusitis.**— This disease is characteristic in turkeys. The cause of the disease is unknown but may be a virus. It appears to be somewhat different in nature from that seen in chickens.

### Symptoms

There is, first, a discharge from the nostrils, followed by the discharge of foamy secretions from the eye. The discharge is clear at first. The sinuses become swollen and filled with a semigelatinous exudate. The appetite remains good as long as the bird can see to eat.

The disease appears to be infectious and although death losses are low, much injury results and the birds become unthrifty and fail to gain weight. Pneumonia occasionally develops. In some birds the infection invades the respiratory tissue and the sinuses are not involved. In many instances it will be difficult to differentiate it from A-avitaminosis deficiency.

### Control

As in most other diseases of the head parts improper ventilation, drafts, overcrowding, wet weather and lack of vitamin A will predispose birds to the infection. Tyzzer<sup>22</sup> recommended the injection of 1 to 2 ml. of freshly prepared 15 percent argyrol directly into the sinus in turkeys. Opening of the sinus may be made by cutting a window in the side with a pair of scissors. The opening should be large enough to allow for complete drainage and prevent rapid healing. The operation may be followed by swabbing the sinus with argyrol or silver nitrate.

Madsen<sup>23</sup> recommends the injection of 1.0 ml. of a 4 percent solution of silver nitrate into the sinus after removal of the exudate by means of a syringe. Recovery requires about 10 days, although in severe cases a second treatment may be necessary.

Since many recovered birds may remain carriers they should be fattened for the market and disposed of as early as possible.

**Fowl Cholera.**— Fowl cholera is an acute disease of all domesticated fowls, characterized by its sudden onset and widespread oc-

22. Tyzzer, E. E. The injection of argyrol for the treatment of sinusitis in turkeys. *Cornell Vet.*, 16:221. 1926.

23. Madsen, D. E. Sinusitis of turkeys and its treatment. *Utah Agri. Exp. Sta. Bul.* 280. 1938.

currence. It is caused by a specific organism, *Pasteurella avicida*, that is found in large numbers in the blood and other tissues of affected birds. The birds seldom live longer than 48 to 72 hours, though the condition may become chronic and persist for weeks.

### Symptoms

In the peracute form no symptoms are usually noticed except that the birds are found dead under the perches in the morning. In the acute type a copious yellowish or greenish diarrhea is noticed; the comb, red at first, later turns to a purple color; the temperature is elevated, loss of appetite is common, and the bird exhibits excessive thirst. Other symptoms that are present are extreme drowsiness, turning of the head, incoördination, paralysis, ruffling of the feathers, and an increase of mucus in the mouth. Death usually occurs in from 24 to 72 hours but some birds live for several days. Hoffman<sup>24</sup> in California found the organism in 48 percent of the birds with ruptured ova.

The chronic type of the disease generally follows an acute attack and is characterized by an intermittent or persistent diarrhea, emaciation, paleness of the comb, and often a stiffness of the joints.

The general hemorrhagic conditions of the tissues and organs is highly diagnostic in birds with acute fowl cholera. The final diagnosis can be confirmed only by the isolation and identification of the organism. A microscopic examination of the blood will reveal typical bipolar-staining organisms. Although this was formerly one of the most serious diseases in Kansas it has not been important for almost 10 years. The reason for this decrease has not been explained.

### Control

The object of treatment after the disease has a start is to try to save the healthy birds. It is best to move the well fowls to new quarters until the disease subsides. Then the infected houses and runs should be thoroughly cleaned and disinfected before the birds are returned. Individual treatment is not recommended in this disease and sick birds should be destroyed and burned. The measures outlined under "Essentials of Poultry Hygiene," page 8, should be carefully followed and the general control measures given under "What to Do in Case of an Outbreak," page 16, practiced. The very fat birds and those in heavy production are the most susceptible to the disease. For this reason the amount of feed should be reduced until the birds recover. Vaccination is not usually recommended. Unless the owner is willing to vaccinate several times at weekly intervals it is best not to vaccinate at all.

If any birds do recover they should be fattened for the market as soon as possible. Any birds which develop chronic cases should be killed, since they might recover, get back into the flock, and, as carriers, be the cause of an outbreak another year.

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24. Hoffman, H. A. 1933. Studies of the etiology of fowl cholera. II Biological properties of *P. avicida*. Jour. Exp. Med. 51:225.

**Apoptectiform Septicemia.** — This is a highly infectious disease of fowls and pigeons caused by a streptococcus (*Streptococcus gallinarum*). The disease is very similar to that of sleeping sickness described by European workers, which is also due to a streptococcus.

#### Symptoms

The disease is rapid in its course. The bird appears listless, remains by itself, will not eat, its gait is staggering, and in time it may develop great prostration. Death may be rapid and some birds are likely to be found dead under the roosts. Diarrhea is usually present if death is not too rapid. The skin of the breast and neck may show areas of discoloration and redness.

When the bird is opened the liver and spleen are found greatly enlarged and paler than normal in color. The surface is usually covered with exudate. There is considerable fluid in the peritoneum and the intestines contain blood-stained mucus. There is a profuse exudate and an abnormal amount of fluid around the brain and spinal cord.

Vaccines and an immune serum have been used with good results, but the authors have had no experience with them. The sanitary methods recommended for the control of fowl cholera should be applied in outbreaks of this disease.

Streptococci have been isolated in several instances from turkeys which exhibited blighted ova. Similar organisms have been reported from hens suffering from diseased oviduct. Streptococcus infection of birds has not been extensively investigated.

**Staphylococcus Infection.** — These organisms cause a variety of infections in poultry. The most common is probably the bumblefoot. Another infection "synovitis" or "staphylococcal arthritis" has been described by Madsen in Utah.<sup>25</sup>

#### Symptoms

He makes the statement that it was first observed in turkeys in Utah in 1935. A high percentage of the flocks now have a few cases. At present it is not known why the disease remains in some flocks with little tendency to spread while in other flocks it assumes epizootic proportions.

The attack may be chronic or acute. In acute cases the birds usually succumb within 48 hours after symptoms are noted. Other birds have an unimpaired appetite and live for many weeks. The droppings are nearly always watery and sulfur colored similar to those seen in blackhead. The birds assume a "squat" position and movements appear to be painful. The skin about the head may be a dark purple color. In some cases there are painful fluctuating swellings above the hock joint. In others conditions similar to bumblefoot are observed.

25. Madsen, D. E. 1948. Staphylococcosis of turkeys. Mimeograph series No. 800. Utah Agr. Experiment Station Div. of Pub.

In acute cases the liver is enlarged and may be dark mahogany or dark green. The kidneys are swollen. Some inflammation of the intestine is the rule. The tendinous insertions and synovial sheaths above the hock joints are infiltrated with excessive fluid and yellowish particles made up of fibrin, leucocytes and bacteria. Small light colored areas are noted in some of the muscles. A fibrinous exudate is sometimes found over the thigh or keel region just under the skin. Cultures prepared from these tissues always show the presence of small staphylococci. Such cultures are pathogenic for experimental birds by injection but not by feeding. The most common method of infection is probably through injuries or drinking of water from stagnant pools.

#### Control

Strict sanitation is very important. Vaccination has not proved successful. The use of sulfonamide drugs is of no value in curing sick birds. Culling and removal of sick birds is important, as in all other infections.

**Pullorum Disease.**—Formerly known as “Bacillary white diarrhea”<sup>26</sup> is a highly acute fatal infectious disease which usually affects the chicks within four to twenty days after hatching. The development of the disease is due to the presence of a specific bacterium, *Salmonella pullorum*. The death rate is very high in most flocks. This, however, depends largely on the manner in which the chicks are managed.

This is by far the most serious disease of young chicks. It is not possible to estimate the losses in Kansas, but probably at least 75 percent of the Kansas flocks are diseased and approximately 5 percent of the hens in these flocks are carriers of the organisms.

#### Symptoms

The chicks appear stupid and remain under the hover or hen most of the time. They remain much by themselves and many of them peep continually, or utter a sharp cry, apparently of pain, when attempting to void excrement. Their feathers become rough and the wings droop. They eat little and appear unable to pick up food. The characteristic whitish discharge from the vent soon makes its appearance. The discharged matter may be creamy or mixed with brown. In many cases this clings to the down in sufficient quantity to occlude the vent. This condition is known as “pasting up behind.” The chicks often become “big bellied” and bunch out behind. In some cases they die without warning and show few symptoms. In other cases they will live for a long time and show all the above symptoms. On post-mortem examination the liver is often found to be of a yellow color and the yolk is un-

26. The reader should keep in mind that not all cases of diarrhea in chicks are due to infection with this organism. Improper feeding, overheating, or chilling, etc., may cause severe losses with symptoms of pullorum disease. A bacteriological examination will determine the cases that are caused by pullorum infection. (See “Some Things which Kill Young Birds,” page 115.) Many cases of so-called brooder pneumonia are due to this infection.

absorbed.<sup>27</sup> In many cases small white points, or areas of necrosis, may be found on or near the surface or on a cross section of the lung. The kidneys are distended with urates, the intestines filled with a white exudate and the muscles are bile-stained. The external symptoms of adult birds are not outstanding and are often confused with those of cholera or fowl typhoid. Death losses among adult birds are low.

The post-mortem lesions in the adult male birds are not characteristic, but in the hen the ovaries are most commonly involved. They appear to be shrunken and ill-shaped, many are discolored and the contents are firm and cheesy. In the male bird the heart and testes are very frequently involved.

Pullorum infection in adult turkeys appears to be considerably more severe than in adult chickens. In many instances the abdominal cavity contains coagulated yolk material and sometimes the entire cavity is filled with a dirty yellow fluid containing large amounts of coagulated yolk and pus. Although such birds appear to be normal they are always very high reactors and are nearly always out of production. In spite of this we have not observed that the disease spreads to any extent among adult birds.

The eggs laid by infected hens may contain the organisms and the chicks which hatch act as a source of infection to other chicks in the same incubator or brooder. Since a chick hatching from a contaminated egg will infect, on an average, some thirty other chicks in the same incubator, it is easy to explain the widespread dissemination of this disease.

Although all birds reacting to the agglutination test do not lay infected eggs, still the difference in loss between reactors and non-reactors is of great significance.

#### Treatment and Control

Treatment of sick birds is unsatisfactory, and only control measures can be practiced. For several years the following method has been used with success in reducing the losses in young chicks. As soon as the chicks are hatched, take them away from the incubator and place them in a freshly scrubbed and disinfected box or brooder. The box should be disinfected and dried in the sun at least once a day, or preferably have a second box to which the chicks may be transferred, while one is being cleaned and disinfected. Keep everything scrupulously clean and dry.

In some cases the organism causing pullorum disease is present in the adult bird and may be transmitted to the young chick through the egg. Since infection may be brought upon the place through purchased eggs or stock, such purchases should be made from farms where the disease is not present.

27. The presence of an ochre-colored liver and an unabsorbed yolk are not always diagnostic for this disease although they are of importance when the age of the chick is considered. The liver does not lose its yellow appearance and becomes a normal red until the chick is 5 to 6 days of age. The yolk may also remain unabsorbed for 5 to 8 days in normal chicks.

It has been found that the disease may be spread from infected to healthy chicks in certain types of incubators. The practice of custom hatching may offset the good results from testing unless all eggs hatched at a time are from flocks which have been tested and carefully culled of all reactors. Heavy losses may result from the eggs of but one or two diseased hens hatched with the eggs of large numbers of healthy hens.

Infertile eggs, dead embryos, and egg shells from the incubators should be boiled thoroughly, to destroy disease germs which may be present, before they are fed to either chicks or adult birds.<sup>28</sup>

A very important source of the infection in adult birds is contact with diseased chicks. This may be easily controlled by preventing the use of the same runs by chicks and adult birds.

In the case of heavily infected breeding stock the marketing of the entire flock, followed by proper methods of cleaning and disinfecting, and then starting with noninfected birds, is probably the best way to get rid of the disease. However, in flocks of high-grade stock, which have been selected for some special purpose, a satisfactory method is to determine which birds are "carriers" of the infection by sending samples of blood to a laboratory for agglutination tests, or make an agglutination test in the field, using whole blood and stained antigen. By this method it is possible to eliminate the infected birds.<sup>29</sup>

Figure 12 shows some of the losses due to pullorum disease such as: Decreased fertility, hatchability, and livability of the chicks. Since it has been determined that the disease may be transmitted from diseased chicks to normal chicks through incubators, all flocks used to supply eggs for custom hatching must be tested to reduce the spread from diseased to free flocks. Every bird reacting to the agglutination test should be removed from the flock, regardless of how valuable it may be.

There are certain reasons why a testing program (using any type of agglutination test) may fail. These may be listed somewhat in order of importance.

1. Failure to test all the birds on the premises.
2. Failure to promptly remove all reactors.
3. Neglect of proper sanitary measures following the removal of reactors. This includes the rotation of runs and disinfection of houses.
4. Purchase of eggs and birds from diseased flocks.
5. Custom-hatching of tested and untested eggs.
6. Failure on the part of the test. This will include the inability of the operator to interpret the results of the test. No test has yet been devised which is not subject to some error. However, a carefully conducted agglutination test by a competent worker is probably better than 95 percent correct in detecting dangerous carriers.

28. Bushnell, L. D., Hinshaw, W. R., and Payne, L. F. Bacillary white diarrhea in fowl. *Kan. Agr. Expt. Sta. Tech. Bul.* 21:1-85. Fig. 4. 1926.

29. For further information see appendix, "Information on the Agglutination Test for Pullorum Disease."

Because of these errors one test each season will not remove all reactors. Tests should be repeated until the flock is clean.

Birds suffering from fowl typhoid, or birds which have been vaccinated for fowl typhoid, will give a positive reaction for pullorum disease, although the influence of the latter will disappear in about 60 days after treatment.

Recent experimental work has shown that proper sanitation and incubation practices are of great value in controlling the dissemina-

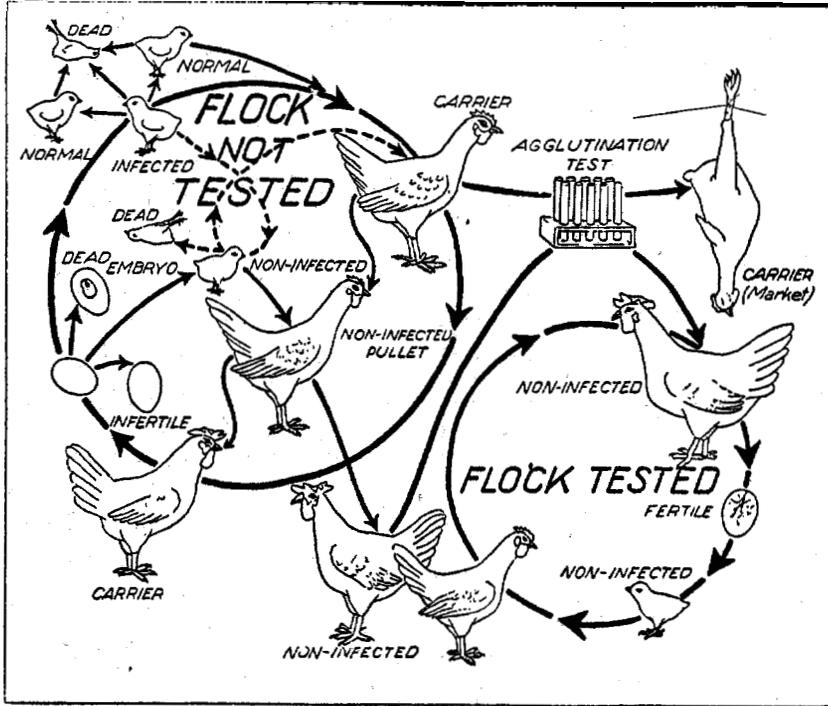


FIG. 12.—Chart showing the possibilities of the agglutination test in controlling pullorum disease in poultry flocks.

tion of this disease in the hatchery and in the incubator. Since the organisms of this disease may be transmitted from infected to healthy chicks in the incubator, the observation of certain measures is important and essential if this infection, as well as others, are to be controlled.

In addition to scrupulous cleanliness in the hatchery the two most important factors to be considered are: A proper relative humidity in the incubator and regular fumigation of the incubators with formaldehyde gas.

A high relative humidity serves the double purpose of reducing the circulation of down from infected chicks and of increasing the effec-

tiveness of formaldehyde fumigation. A wet bulb thermometer reading of 85° to 90° F. is desirable at the time of fumigation.<sup>30</sup>

Neither the very young chicks nor the eggs seem to be injured if the formaldehyde fumigation is carried out as recommended.

Fumigation may not reach disease germs that are covered by dirt or down. It is, therefore, essential to clean the incubator thoroughly and carefully at regular intervals, preferably after each hatch.

Although fumigation with formaldehyde kills the disease germs in the incubator and thus prevents spread of infection from one end of the incubator to the other, it cannot and will not destroy germs such as those of pullorum disease which are in the body of infected chicks or inside the egg. It, therefore, merely destroys infection in the air and on the incubator trays, but does not keep the diseased chicks from infecting others in very close contact with them. For these reasons FUMIGATION OF THE INCUBATOR CANNOT BE CONSIDERED AS A SUBSTITUTE FOR TESTING AGAINST THE DISEASE or as an insurance against losses due to other causes.

The United States Department of Agriculture, Bureau of Animal Industry, has developed a national poultry improvement plan which includes a section on pullorum control and eradication. The plan now includes turkeys as well as chickens. Under this plan flocks are classed according to the method of testing and the number of reactors found. These may be described briefly as follows:

#### U. S. Pullorum-Tested Class<sup>31</sup>

All chickens more than 5 months of age to be used as breeders are to be tested by an official pullorum tester or a testing agent and the reactors removed from the premises. Each flock must contain fewer than 6 percent of reactors in 1944-'45, and fewer than 5 percent of reactors in 1945-'46 and following years.

The testing work must be done within the 12 months immediately preceding the date of sale of hatching eggs or chicks.

All chickens introduced into the breeding flock must likewise have been tested and be negative to the test used.

Eggs from nontested flocks are not to be incubated in the same machine or in the same room with chicks from U. S. Pullorum-tested flocks.

#### U. S. Pullorum-Controlled Class

The requirements for this class are the same as for U. S. Pullorum-Tested, except that the tolerance is fewer than 2 percent of reactors and that incubation and hatching from nontested flocks are not permitted.

#### U. S. Pullorum-Passed Class

All chickens on the premises are to be tested after 5 months of age by an official pullorum tester.

The flock must not contain reactors on the last test made within

30. See Bushnell, L. D., and Payne, L. F. Dissemination of pullorum disease in the incubator. *Kan. Agr. Expt. Sta. Tech. Bul.* 29:1-60. Fig. 10. 1931.

31. The national poultry improvement plan. 1941. U. S. D. A. Miscellaneous Publication No. 800 and revisions.

the testing year immediately preceding the date of sale of hatching eggs, chicks, or breeding stock.

Birds introduced into the flock must be from U. S. Pullorum-Passed or U. S. Pullorum-Clean flocks.

No eggs other than from U. S. Pullorum-Clean flocks are to be incubated in the same incubator or in the same room with eggs from U. S. Pullorum-Passed flocks.

No chicks other than from U. S. Pullorum-Clean flocks are to be hatched or brooded in the same machine or in the same room with chicks from U. S. Pullorum-Passed flocks.

### U. S. Pullorum Clean Class

The first year all birds, and after the first year all birds to be used as breeders, are to be tested annually by a state pullorum tester.

The flock must not contain reactors in two consecutive tests not less than six months apart, the last test being made within the testing year immediately preceding the date of sale of hatching eggs, chicks, or breeding stock.

Birds introduced into the flock must be from only U. S. Pullorum-Clean flocks.

Eggs from non-tested, U. S. Pullorum-Tested, U. S. Pullorum-Controlled, or U. S. Pullorum-Passed flocks are not to be incubated in the same hatchery with eggs from U. S. Pullorum-Clean flocks.

Chicks from other flocks are not to be hatched or brooded in the same hatchery with chicks from U. S. Pullorum-Clean flocks.

The official test for pullorum disease under the national poultry improvement plan shall be one of the following agglutination tests:

- (a) The standard tube agglutination test, as described in the Proceedings of the U. S. Livestock Sanitary Association, November 30 to December 2, 1932, pages 487 to 491, or;
- (b) The stained-antigen, rapid, whole-blood test, as described by Schaffer, MacDonald, Hall, and Bunyea, in the Journal of the American Veterinary Medical Association, Vol. 79 (n. s. 32), No. 2, pp. 236-240, 1931, and covered by U. S. Patent 1,816,026, or;<sup>32</sup>
- (c) The rapid serum test, as described by Runnels, Coon, Farley and Thorp, Journal of the American Veterinary Medical Association, Vol. 70 (n. s. 23), No. 5, pp. 660-662, 1927.

The stained antigen used in the whole-blood testing (see *b* above) for pullorum disease shall be approved by the United States Department of Agriculture.<sup>33</sup>

Further details of the plan may be obtained by writing the United States Department of Agriculture, Washington, D. C.

**Fowl Typhoid.**—Fowl typhoid is an acute infectious disease of fowls that affects both young and old birds. It is caused by *Shigella gallinarum*, an organism that somewhat resembles the one causing typhoid fever in man.

<sup>32</sup>. The whole-blood stained antigen test has not been accepted as official for the testing of turkeys.

<sup>33</sup>. Bunyea, H. 1939. Use of the rapid whole-blood test for pullorum disease. U. S. D. A. Miscellaneous Publications No. 349.

**Symptoms**

The acuteness of fowl typhoid often causes it to be confused with fowl cholera. However, it is not usually as highly fatal as cholera. Birds that have shown no symptoms may be found dead under the roost and about the yard; others will show a tendency to stray from the flock; they will become weak and have a greenish diarrhea. It is generally believed that a pale comb is characteristic, but the cases that have been examined at this laboratory seem to show a bright red comb as often as an anemic one. The appetite is lost and the affected fowl shows a rise in temperature as indicated by its increased thirst. Five or six days after symptoms are noticed the birds will usually be found dead, although a few may recover. Birds stand about the yard with drooping head and wings.

Upon opening a fowl that has died, an enlarged, darkened, greenish, or mahogany liver covered with minute, necrotic (grayish) spots is noticed. The spleen is usually mottled in appearance, and the gall bladder distended with thick bile. The kidneys may be enlarged and friable (easily broken). The heart often shows several small necrotic or fatty areas on its surface.

**Control**

The same treatment outlined for fowl cholera should be practiced. If the best possible care is taken somewhat better results may be obtained than with cholera. The free use of Epsom salt and potassium permanganate will control this disease except in severe outbreaks. Bacterial vaccines have also been used with success in controlling the disease. Like fowl cholera this disease has become of little importance in Kansas.

**Colibacillosis of Chicks.**— This disease, although not very common, has been found to cause heavy losses in chicks from two to eight weeks of age. This infection has been reported for poults, ducklings and goslings. Certain bacteria, chiefly *E. coli*, which are normally present in the intestines and which do not cause disease when confined to the intestines, may gain entrance to the blood and body organs and tissues and thus cause colibacillosis. Unfavorable conditions of feeding, brooding (especially overcrowding) or sanitation may weaken the chicks to the extent that general infection readily occurs. The symptoms may cause one to suspect pullorum disease, but the losses can be more readily controlled than in the latter disease. Affected chicks may become droopy and show signs of difficult breathing, others may die rather suddenly with only mild symptoms. There is no specific treatment for this disease.

Filthy and overcrowded brooders are factors that must be corrected. All sick chicks should be removed as soon as they are noticed and care taken to prevent contamination of the feed and water with the droppings.

**Paratyphoid Infections.**— Many domesticated birds are susceptible to infection by the "paratyphoid" group of bacteria. Two

of these diseases, pullorum disease and fowl typhoid, have already been discussed. However, there is a group of less common infections, distinguished from the above by clinical and bacteriological findings, which are important in certain localities and under certain conditions of management. The bacteria involved are frequently referred to as the "food poisoning group." At present the classification of these organisms is not well established, but in general, they are of the *Salmonella aertrycke*, or closely related type. These organisms have been reported from infections of young chickens, turkeys, ducks, geese, quail, canaries, pigeons, and parrots.

### Symptoms

The symptoms vary with the different species, but in general the birds exhibit loss of appetite, high temperatures, increased thirst, a slight to severe diarrhea, and ruffled feathers which is described as a "puffing up" in canary birds. Losses may reach 90 percent.

Emmel<sup>34</sup> has reported this organism either of direct or indirect importance in leucosis. This point requires further study. There is frequently a severe inflammation of the eye, leading to an ophthalmia. In pigeons sometimes there is marked wryneck. These birds frequently reveal swollen joints and inability to fly to the perches.

Recent reports from California and other stations indicate that this infection may cause heavy losses in young poults. The most severe losses occur in the first 10 days after hatching. Weakness appeared to be the most common symptom. A small percentage showed diarrhea. The sick birds which had recovered continued to exhibit weakness for long periods. Most of the birds that died under 10 days of age had pneumonia and about half retained the yolk sac. The livers were pale and mottled and many had white, cheesy plugs in the cecum. Poults 12 weeks of age were susceptible on exposure to contaminated runs, but young chicks did not become diseased under these conditions. In infected flocks about one-third of the breeding hens have been found to be reactors (and carriers) of the infection, in dilutions of 1:50 or above, by means of the agglutination test. Heavy losses have been reported in young geese and ducks. The affected birds lack energy and sometimes fall over on their backs and die. This has been spoken of as "keel disease."

The spleen, kidneys and liver are usually swollen; the lining of the intestines congested and the lumen filled with a slimy mass. A fibrinous exudate is seen in the peritoneum and on the heart. When the joints are involved they are swollen and the cavity is filled with a straw-colored viscous material.

### Control

With farm birds a careful sanitary program and careful culling of all diseased individuals will generally stop the losses. In pigeons it will be much more difficult to control these infections because of

<sup>34</sup> Emmel, M. W., 1935. The etiology of fowl paralysis, leukemia and allied conditions in animals. Fla. Agr. Expt. Sta. Tech. Bul. X, p. 24. 1937.

the peculiar methods by which the adult birds feed the young. In case the disease becomes serious in these birds the best method of control is to destroy all those remaining. Among pet-stock birds the disease may be controlled and largely eliminated by means of careful sanitary supervision, and frequent culling and removal of all sick birds. No doubt the agglutination test to detect carriers could be used to control the disease. It would be a special advantage to prepare such antigens from cultures isolated from the flock to be tested since there are many serological types in this group. It will be necessary to consult a laboratory for information.

**Tuberculosis.**—Tuberculosis is generally called “going light” by the poultryman. It is caused by a microorganism, *Mycobacterium tuberculosis*, (avian type) similar to that which is responsible for the same disease in man and cattle. The incidence of avian tuberculosis varies greatly throughout the United States. It is much more prevalent in the North Central States where it is estimated that 50 to 60 percent of the flocks are diseased. It is not very probable that man will contract the disease from fowls, but cases are reported where birds have died from the type that affects the human, and it is possible that man may occasionally get the disease from birds. Swine may become infected with avian tuberculosis by association with affected birds. Cattle are only slightly susceptible to the avian tubercle bacillus. Whatever infections develop tend to remain localized and the cattle become sensitive to avian tuberculin and some react to mammalian tuberculin. Cattle and swine should not be in the same yards with tuberculous chickens. The greatest source of infection of birds is from other birds that have the disease. All classes of fowls are susceptible to the infection, but the disease is most common among chickens. The rate of spread is in direct relation to crowding and sanitation. Van Es and Martin devised a method of classifying the various types of tubercle bacilli as shown in Table 2.

#### Symptoms

The disease runs a chronic course and usually the first indication that it is on the farm is that a bird will be found that is “going light.” The comb will become pale and when picked up it will be noticed that the bird has very little flesh on its breast. The bird will eat well until death and only one or two in the flock may be noticed with the disease at one time, although it is usually widespread in an affected flock. Birds may die a few at a time or singly over a considerable period. Paralysis and lameness are quite common in the more chronic cases.

The surest method of diagnosis is to kill an infected fowl and observe the lesions in the liver, spleen, and intestines. A few will show no lesions at all, but these cases are rare. Lesions are seldom noticed in the lungs. Occasionally the joints are affected, and skin tubercles may be seen. In most cases of tuberculosis of the fowl tubercles are easily demonstrated in the marrow of the long bones of the leg. The lesions commonly seen are white to yellow tubercles

of various sizes, few to many in number, on the surface of the liver, and on the surface of an enlarged spleen. These tubercles may or may not be found along the intestinal tract. (Fig. 13.) When lesions are present in the walls of the intestines they are firm to the touch, irregular in outline, and yellowish in color. They generally are of cheesy consistency and when cut open show a central area of softer material than that which makes up the outer portion of the lesion.

TABLE 2.—CLASSIFICATION OF DIFFERENT TYPES OF TUBERCLE BACILLI

TYPE OF BACILLUS.	Reaction of various animals and birds.			
	Guinea pig.	Rabbit.	Chicken.	Parrot.
Avian.....	0	+++	+++	+++
Bovine.....	+++	+++	0	+++
Human.....	+++	+	0	+++

The + indicates slight localized infection, the +++ indicates a generalized and fatal type of infection. Modified after Van Es and Martin (Van Es, L., and Martin, H. M., "The Incidence of Avian Tuberculosis in Mammals Other than Swine." Neb. Agr. Expt. Sta. Res. Bul. 49, p. 132, 1930).

**Control**

Treatment of an infected fowl is useless, and once tuberculosis gets into a flock destruction of the entire flock is the only sure method of eradication. However, since the disease usually is more prevalent in older birds, a cheaper method is to get rid of all birds over one year of age each year for a number of years, and thus gradually eradicate it from the flock. A third and much better method is to have a veterinarian apply the tuberculin test on each bird at least twice a year and remove all reactors.<sup>35</sup> The cost of this method is low when one considers that all healthy individuals may be saved when this test is used as a means of detecting the infected birds. Birds reacting to the tuberculin test should not be sold on the market. Not only must the infected birds be removed, but the premises must be carefully cleaned and disinfected. Especially should all runs under old sheds and barns be closed so that birds cannot get into these places. The tubercle bacillus will live in the dark and in refuse for long periods of time. The organisms have been found to remain alive and virulent after two years in moist soil. If the entire flock is killed new birds should not be brought on the place for at least six months. During this time the premises should be thoroughly disinfected at frequent intervals. Extreme care should be taken to disinfect thoroughly and often in any case. The soil should be plowed and cropped if possible.

All birds that are killed need not be a total loss, for those showing

35. The test consists in injecting a small amount of tuberculin into the skin of the wattle. In a diseased bird there is a swelling within 24 hours, which persists for about 48 hours. In noninfected birds there is no, or very slight, swelling which disappears in 24 hours. This test is very highly efficient in detecting diseased birds.

no lesions are suitable for food if they are thoroughly cooked. Therefore, if the entire flock is to be killed, the birds may be dressed and those that show no signs of the disease may be sold to the butcher. All affected fowls should be burned.

**Botulism (Limberneck).**—Botulism (limberneck) is a disease caused by the toxins of a microorganism that is common in spoiled food or grain. The organism, *Clostridium botulinum* (types A and C), is commonly found in spoiled foods or decaying carcasses of animals. The disease is characterized by limberneck and is often called by this name.

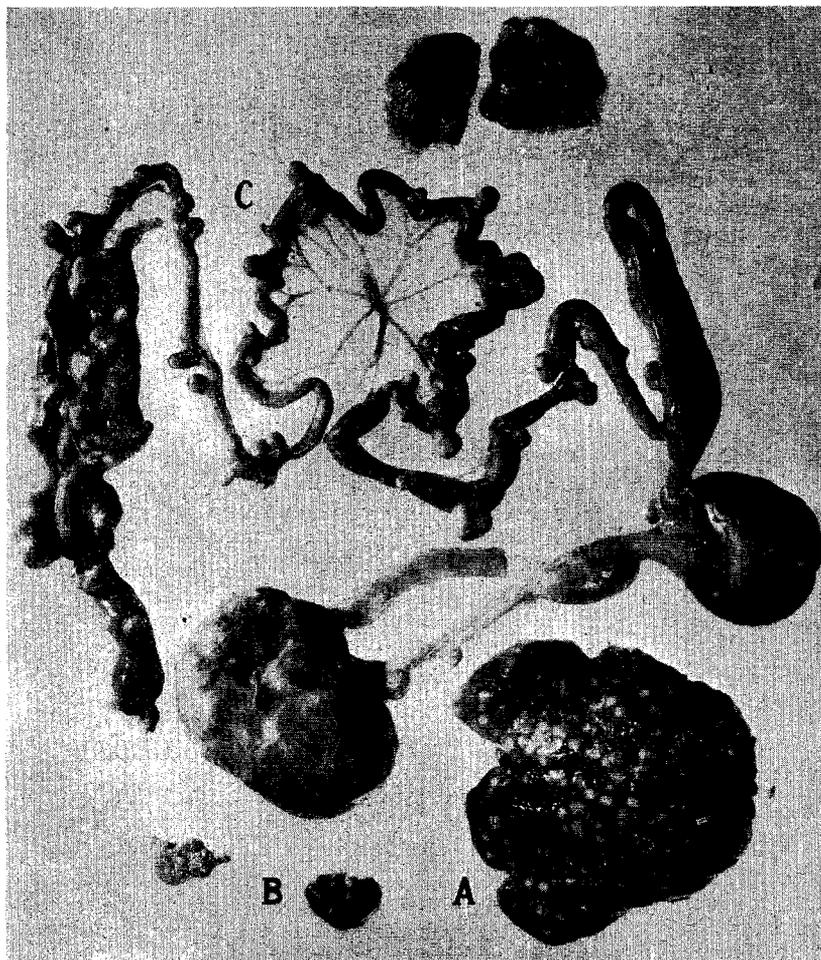


FIG. 13.—Viscera of a tuberculous bird. (A) Liver. (B) Spleen. (C) Intestines.

### Symptoms

A sudden appearance of several cases of typical limberneck in the flock is usually the first indication of the disease. This condition is caused by paralysis of the neck muscles, which allows the neck to hang limp. It must not be confused with the wryneck found in birds heavily infested with worms or coccidia, or disease of the ear where the neck is twisted or held to one side but does not exhibit the limpness found in botulism. A bright red comb, ruffed feathers easily pulled out; and a limber neck are probably the most characteristic symptoms of the disease. Usually a large number of the flock are affected at one time, and are found lying in a prone position. When picked up they will utter a cry of pain. A subnormal temperature is sometimes present, but it does not seem to be a constant symptom. A watery or whitish diarrhea may be present, and the skin, soiled by this discharge, may appear red and congested.

Often when a bird that is dead from the disease is opened and the crop examined a number of maggots and bits of decomposed meat will be found. There is usually a putrid odor of decomposed meat noted in the mass of material found in the crop. Sometimes the crop will be filled with spoiled corn or other food, or feathers and bits of flesh that have carried the poisonous material.

### Control

First of all, the cause should be sought for and removed. Often, when there is no knowledge that spoiled food has been obtained, a careful search about the premises will reveal a dead and decaying carcass of a bird, rabbit, or other animal. Spoiled ensilage and canned foods are examples of food that might harbor the organism, and these should be considered when looking for the cause.

The sick birds should be moved to a cool place and given a physic, such as a teaspoonful of Epsom salt in a half tumbler of water, or two teaspoonfuls of castor oil to each fowl. The unaffected fowls should be shut up until the cause is removed and given a dose of Epsom salt or oil as described above. Sometimes simply shutting birds into small runs or changing the feed will be sufficient to stop the loss, since this keeps the birds away from the poisonous material.

## DISEASES DUE TO HIGHER FUNGI (MOLDS)

In this section we have described those diseases due to the action of certain parasitic fungi which are considered as somewhat more complex and highly developed than bacteria. Fungi may be classified as plants without stems, leaves, or roots, and destitute of chlorophyll. Among the important disease-producing genera are *Lophophyton*, causing favus; *Aspergillus*, causing aspergillosis; and *Monilia (oidium)*, causing moniliasis (thrush or soor).

Favus (White Comb).—Favus is caused by a fungus (*Lophophyton gallinae*) (*Achorion gallinae*) that attacks especially

the wattles and comb, but may spread to other portions of the body. When the crusts are removed the skin appears irritated and somewhat raw. If the feathered portions become affected the feathers become dry, erect, and brittle and finally break off or fall out, leaving a disk-shaped scale with a depression at the bottom where the feather was located. The affected parts appear white, as though covered with powder. The disease often spreads rapidly. Figure 14 illustrates an extreme infection of this type.

#### Control

After removing as much of the scale as possible with warm water or glycerine and gently scraping with some blunt instrument, apply tincture of iodine. Early stages of the disease often respond favorably to an application of lard or oil, or to a salve made by mixing about equal parts of lard and sulphur. This mixture should be worked into a smooth salve before using. A formaldehyde ointment has been recommended from the Wisconsin Experiment Station (see Appendix). Keep the birds apart during treatment. Follow with the usual clean-up methods.

***Aspergillosis (Brooder Pneumonia).***—A cause of brooder pneumonia in young chicks and aspergillosis in adult birds is the mold known as *Aspergillus fumigatus* or *A. niger*. The incidence of the condition is not great. These molds are very common in nature, especially on grain and hay kept in damp places. Crowding in a poorly ventilated brooder house is a predisposing factor that favors the entrance of the mold into the bodies of the chicks.

This type of pneumonia should not be confused with that due to infection with pullorum disease, which is very common in incubator-hatched chicks. A similar condition has been observed in the air sacs and thorax of pigeons, ducks and geese.

#### Symptoms

The brooder chick, when affected, shows symptoms resembling those of pullorum disease. The disease affects the pulmonary system as a typical pneumonia. In the adult the disease may be limited to one bird, or several may show symptoms at the same time. Accelerated breathing, a slight catarrh, and a rattling (or croupy) sound on expiration are characteristic of the disease. The birds also stray from the flock and are often found sitting in a corner of the pen. If an attempt is made to pick up a sick bird, it will show signs of pain. Fever, choking, diarrhea, sagging wings, sleepiness, and finally suffocation precede death. In some cases, where only the air sacs are involved, loss of flesh and weakness are the only symptoms noticed, though at times lameness and swollen joints are prevalent. The quail is frequently affected by fungi of this group. In these birds it presents somewhat the appearance of tuberculosis. The lesions are scattered throughout the organs as yellow necrotic masses from which the organisms may be cultivated. These nodules may vary in size from a pinhead to a pea. There may also be local areas of inflammation.



FIG. 14.—An extreme infection by the *Favus* fungus.

Hinshaw has reported on an outbreak of aspergillosis in turkeys due to contaminated cans and barrels used for the transportation and storage of milk. Such utensils should be scalded daily to prevent growth of molds.

**Control**

Aspergillosis is difficult or impossible to cure. Coal tar or turpentine inhalations have been recommended, but are of no value.

Dry, well-ventilated brooder houses should be provided and the temperature in these should be carefully regulated. Crowding and huddling indicate lack of heat and the brooder stove or lamp should be regulated accordingly.

Only dry, clean litter should be used and dusty and moldy grain must be avoided. Isolation and disinfection methods previously outlined should also be followed.

**Thrush.**—This disease is caused by the action of a fungus belonging to some species of the genus *Monilia* (*Oidia*). It has become widespread and is especially important as a disease of turkeys in the southwestern part of this country. It is also a common complicating factor in other types of infection. It is much less important in chickens.

**Symptoms**

The disease is not acute, although inoculated birds begin to die within one week. The birds appear listless, lack appetite, and stand with the head drawn down. The breast has a shrunken appearance. Generally a diagnosis is not possible without a post-mortem examination.

The pathology of the disease has not been well studied. The most evident lesions are in the crop, where very extensive ulcers develop on the upper wall. These may extend into the mouth and the proventriculus. The areas are covered with a false membrane which is raised, rough, and gray in color.

**Control**

Control is not difficult from the standpoint of prevention, but there is no cure for birds already affected.

If the lesions are confined to the mouth the membrane may be removed and the ulcers treated with tincture of iodine. If the lesions are extensive, treatment is not successful. Since many of the diseased birds also suffer from malnutrition an improvement in the feeding program is necessary.

Careful sanitation and the feeding of clean grain, free of mold, in clean, dry hoppers will reduce the amount of the infection. A solution of copper sulphate (blue stone, blue vitriol), 1 to 2,000 (1 level teaspoonful of crystals to 5 gallons of water), in place of drinking water has been proved of value in preventing the initial infection.<sup>36</sup> This should be given to the birds for one week and discontinued for one week and again repeated several times.

<sup>36</sup>. Solutions stronger than this are not consumed readily and birds may be injured if forced to drink them.

## DISEASES DUE TO PROTOZOAN PARASITES

There are a number of very important poultry diseases due to protozoa. These organisms are single-celled and belong to the animal kingdom. Some of them have simple and direct life cycles, others require intermediate hosts in which certain stages are developed.

**Coccidiosis.**—Coccidiosis is a protozoan disease found most commonly in chicks from two weeks to four months of age. Although older birds are often affected, young chicks appear to be resistant. The disease is found in all domesticated and many wild birds. It was formerly believed that the species of coccidia from the sparrow could affect chickens, but according to Tyzzer this is probably not the case.<sup>37</sup> In fact, most species of this parasite are rather closely confined to certain host species.

Most of the fatal coccidiosis in chickens is due to two species, *Eimeria tenella* and *E. necatrix*, although there are several other species which are more or less injurious according to the condition of the bird and the system of management. Some of the species of coccidia do little harm.

The coccidia cannot be seen with the naked eye, a microscope being necessary to detect their presence and to differentiate between the various types.

The life history of coccidia is complex, involving both a sexual and an asexual cycle. The number of asexual cycles which occur in the intestines is not known and varies with each species. It is during this part of the cycle that the greatest damage to the intestinal membrane occurs.

Within the intestine most species develop rapidly. Tyzzer has estimated that *E. tenella* may produce over one and one-half million organisms in four or five days.

The stage in which the coccidium is passed from the intestine is called an oöcyst. In this stage it is not infective and will not produce the disease until it has been allowed to develop for a day or two under favorable conditions of temperature and moisture in the soil. When the cysts become mature an infection results if they are taken into the intestine with contaminated feed and water. The young parasites escape from the cyst and penetrate the cells of the intestinal wall where they grow rapidly, destroying the cells and causing severe inflammation, and hemorrhage. A few days later the bird again passes large numbers of cysts and the cycle is continued.

The location of the parasite in the intestine will depend on the species of coccidia present. One species, *E. tenella*, is limited largely to the ceca, the *E. necatrix* to the middle small intestine, while others show a variety of preferred locations according to the species.

Most writers believe that the infection is self-limiting and will disappear after the bird has acquired a resistance to further at-

37. Tyzzer, E. E. Coccidiosis in Gallinaceous birds. Amer. Jour. Hyg. 10, p. 1. 1929. Amer. Jour. Hyg. 11, p. 319. 1932.

TABLE 3.—CHARACTERISTICS OF THE MORE IMPORTANT AVIAN *Eimeria*.

Species of <i>Eimeria</i> .	HABITAT.	Develop- mental period, days.	Sporula- tion, hours.	Oöcyst, shape.	Size of oöcyst,* microns.	Degree of patho- genicity.	Immunity.
<i>E. tenella</i> .....	Ceca and lower intestine (chicken) .....	7	25-48	broad ovoid .....	42.6 x 19.0	++++	Delayed.
<i>E. mitis</i> .....	Anterior small intestine (chicken) .....	5	40-48	spherical .....	16.2 x 15.5	+	Delayed.
<i>E. maxima</i> .....	Middle and posterior small intestine (chicken) ..	6	48	egg shaped .....	29.3 x 22.6	++	Delayed.
<i>E. necatrix</i> .....	Small intestine (chicken) .....	7	48	oblong ovoid .....	16.7 x 14.2	++++	Delayed.
<i>E. praecox</i> .....	Upper third of small intestine (chicken) .....	4	48	ovoidal .....	21.3 x 17.1	+	Prompt.
<i>E. acervulina</i> .....	Upper small intestine (chicken) .....	4	24	ovoid .....	18.61 x 15.08	+	Delayed.
<i>E. hagani</i> .....	Anterior half small intestine .....	7	48	broad oval .....	17.6 x 19.1	++	Prompt.
<i>E. phasiani</i> .....	Entire intestinal tract but chiefly lower small intestine (pheasant) .....	5	24	long, ellipsoid ..	23.04 x 15.89	+	Delayed.
<i>E. dispersa</i> (pheasant strain) ..	Small intestine (pheasant) .....	4 or 5	40-48	broad ovoid .....	19.79 x 17.72	+	?
<i>E. meleagrimitis</i> .....	Small intestine (turkey) .....	6	.....	ovoid, variable ..	18.12 x 15.28	+	Prompt.
<i>E. meleagridis</i> .....	Ceca (turkey) .....	5	24	ellipsoid .....	23.79 x 17.33	+	Prompt.
<i>E. dispersa</i> (quail strain) .....	Upper small intestine (quail) .....	4	24	broad ovoid .....	22.75 x 18.84	+++	?

\* The figures are based on measurements of one hundred oöcysts, except in the case of *E. dispersa* from the pheasant and *E. meleagrimitis* from the turkey, for each of which only twenty oöcysts were measured. From report by Tyzzer. Except for *E. hagani*.

tacks. This is indicated under the heading of immunity in Table 3.

The oöcysts are very resistant outside the body. Edgington and Broerman<sup>38</sup> found that oöcysts stored at about 40° F. were infectious for 30-day-old chicks after two years. However, complete drying was injurious.

It has been found that the cysts will accumulate in enormous numbers in the droppings. As many as 112,300 have been found per gram (approximately 28 grams per ounce) of litter and droppings under the perches, and 42,600 per gram of sediment in the drinking fountains. Chickens have been found to become carriers of the parasite for long periods of time, over seven months from the date of infection. After ten or twelve months the cyst formation is rare and is not capable of causing an infection. Cysts have been found to live for 197 days in the soil.

#### Symptoms

The symptoms in general so resemble those of some other diseases, such as worms, or nutritional disease, that it is almost impossible to diagnose the condition except by autopsy and a microscopic examination of some of the intestinal contents to determine the presence or absence of harmful species of coccidia. There are two general types of the disease in chickens. One type, the cecal coccidiosis, which is an acute disease, and the second or duodenal coccidiosis, in which symptoms are exhibited over a long period of time.

The first symptoms noticed in the acute form are that the affected bird becomes droopy, the wings sag (Fig. 15) and the bird lags behind the rest of the flock. In severe infestations the droppings may consist of almost pure blood. Usually a large percent of chicks will show symptoms at the same time. Nutritional diseases may be complicating factors, since the sick birds do not eat the proper amount of feed. The irritation that is set up makes a favorable condition for secondary bacterial infection.

The chicks may die in a few days after the first symptoms are noticed, or they may live and eventually recover. The symptoms of chronic coccidiosis are slow to develop. The birds are usually poorly feathered, pale, and thin. In older birds the combs are blue and the birds are inactive and may exhibit extreme emaciation. Egg production is decreased. If the local veterinarian is not in a position to make an examination for coccidiosis, one or two of the birds should be shipped to the Department of Bacteriology for examination.

#### Control

Treatment is very unsatisfactory in most cases and control measures must, therefore, be directed toward preventing the disease from getting a start on the premises. Coccidial infections are usually self-limiting and in most instances outbreaks will begin to subside by the time treatment is instituted so that the treatment will receive

38. Edgington, B. H., and Broerman, A. Ohio Agr. Expt. Sta. Bul. 470:186-187. 1931.

an undue amount of credit for its control. Some of these infections are more chronic than others, but when the acute types become chronic it is an indication of continued reinfection due to improper methods of management. Care should be exercised to prevent introducing coccidiosis with chicks from infected flocks and other means of infecting premises such as the use of contaminated litter, coops, grain sacks, vehicles, pigeons, and other wild birds must be guarded

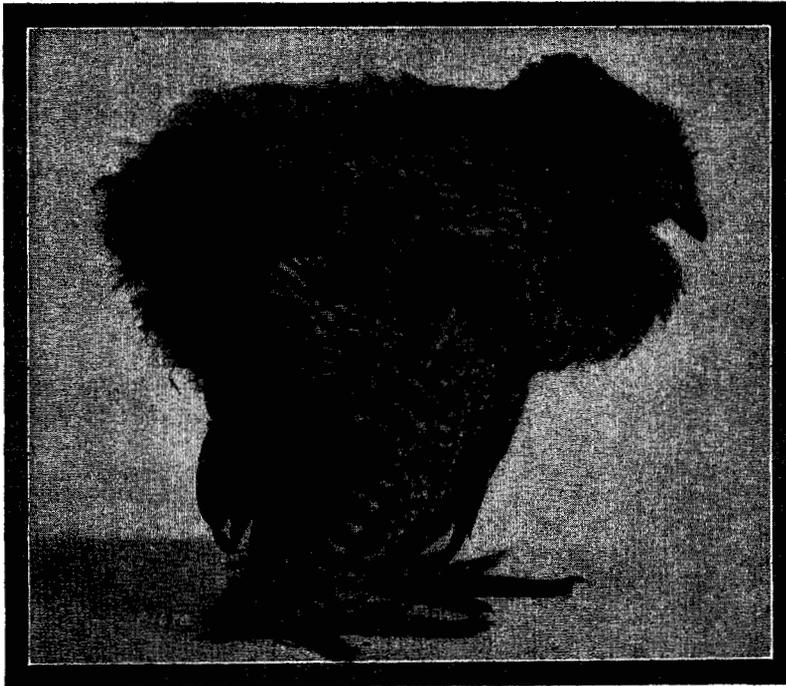


FIG. 15.—A chick six weeks of age suffering from acute coccidiosis.

against. Movable brooder houses and rotation of runs will help to prevent an outbreak.

Since old birds may be carriers of the coccidia, the chicks which are incubator hatched should not be allowed to use runs previously occupied by adult birds. If new premises cannot be provided, concrete, gravel, or hail-screen runs are important aids in preventing the spread of coccidiosis. Properly constructed gravel runs drain well and consequently do not provide the moisture necessary for the development of the coccidia outside of the body of the fowl. Concrete runs can also be kept dry by cleaning at least three times a week and preferably each day. Hail screen is always dry and is self-cleaning. Runs made of hail screen will be of special value in protecting young birds from infections.

When the disease appears care must be taken to prevent its spread by removing the affected individuals from the flock. The healthy chicks should be moved to new, clean premises or they may be kept on gravel or sanitary concrete runs. Removing all contaminated litter at least once each day and replacing with fresh litter will do much to control the disease. The water should be changed frequently and the utensils scalded each time. The common disinfectants recommended for drinking water have no effect whatever on the cysts of the coccidia. However, they may be destroyed by boiling water.

Powdered crude catechu at the rate of one-third teaspoonful per gallon of drinking water has given good results when kept before the birds continually. Epsom salt should be given every ten days while catechu is being used, since the catechu is constipating in its action. Sulfaguanidine at the rate of one pound to one and one-half pounds per 100 pounds of mash has been found experimentally to be effective in preventing infection with severe types of coccidia. This should be fed for three or four days after the first case is observed. At present this drug is so expensive that it will probably not come into general use. The effect of prolonged use on the health of the bird has not been determined.

Chickens should receive two pounds of high-grade cod-liver oil or the equivalent of other source of vitamin A in each 100 pounds of mash throughout an outbreak. Birds with this infection appear to require more vitamin A than normal birds.

It has been reported from the Wisconsin station that the addition of flowers of sulphur to hopper-fed dry mash would prevent infection of chickens by coccidia.

A more recent report indicates that the use of more than 2 percent is likely to slow up growth and cause a condition called sulphur rickets. Two percent appears to be safe if chicks are allowed to run in the sunshine, but involves some risk if chicks are to be kept inside for a month or more.

Dicoce is a special mixture of sulphur and urea put out by a commercial company and is reported to be effective in controlling certain types of coccidiosis (*E. tenella*). Two percent of the mixture is added to the mash and fed for a 14-day period, with 7-day rest periods followed by a 7-day treatment when chicks are 3 or 4 weeks of age.

For the chronic forms of coccidiosis, the only means of control is by rearing the birds in such a way that they are protected from the infection. Regardless of the method of control followed, the sanitary measures must be considered of first importance. This prevents continued reinfection from outside sources.

**Blackhead (*Infectious Enterohepatitis*).** — Blackhead is one of the most common of the diseases affecting turkeys, and is very prevalent in Kansas. It is caused by a microparasite that affects especially the liver and ceca (blind pouches of the gut) of birds from six weeks to four months of age. Older turkeys and chickens are

not immune. In fact chickens may be a source of infection and not show signs of the disease. The term "blackhead" is misleading, since any disease that causes a decrease in the oxygen supply of the blood or impairs the circulation may cause the head to become darkened in color. *Histomonas meleagridis* is now known to be the cause of blackhead, and some investigators maintain that the presence of the small roundworm, *Heterakis gallinae*, is also essential in protecting the blackhead parasite through the period when it is in the soil.

#### Symptoms

The disease runs a rapid course in young birds, while in older ones it usually causes death in three or four weeks after the first indication of infection. The characteristic symptoms are drowsiness, loss of appetite, diarrhea, and sulphur-colored droppings. As was mentioned before, the "black" head is not a constant symptom and may even indicate some other disease. As the disease progresses the feathers become ruffled, the wings droop and general debility is noticed. (Fig. 16.) Several poults usually develop symptoms at the same time. The diseased birds will lag behind the remainder of the flock when in motion.

When a post-mortem is made, the liver and the ceca should be examined for lesions. Yellowish or yellowish-green areas are seen on the surface of the liver (Fig. 17) in most cases, but some do not show these changes. The ceca are generally impacted with a thick mass of foul-smelling necrotic material and the inner surface may show an ulcerated condition. The ulcers may be large or small and may perforate the wall of the cecum and lead to peritonitis.<sup>39</sup>

#### Control

Treatment of blackhead is usually of little value, the only hope lying in prevention. A treatment that is now being used by some is as follows: For each twenty birds give two teaspoonfuls of powdered ipecac, mixed in a mash, twice a week until the poults are three months of age; then reduce the dosage one-half for ten days until the birds are ready for the market. Crude catechu at the rate of one-third teaspoonful per gallon of water is also recommended where it can be kept before the flock continually. Fresh water should be given often and the fountains kept thoroughly cleaned and disinfected at all times. Epsom salt should be given at the rate of one and one-half pounds per one hundred adult birds. This may be given in a wet mash or drinking water and the dose should be repeated once every two weeks while catechu is being given.

Certain other preventive measures that should be observed: Do not allow chickens and turkeys to run together, since the former may harbor the disease and show no visible symptoms; quarantine all newly purchased birds for thirty days before admitting them to the

39. The *Trichomonas gallinarum* sometimes produces lesions similar to those seen in black-head except that they are usually smaller and more irregular in outline. The two conditions can be differentiated by microscopic examination.

flock; and do not feed the poults on the same area for long periods of time, since the soil is apt to become heavily contaminated with the causative organism and thus serve as a continual source of fresh infestation. Eggs for hatching should be purchased only from healthy flocks.

In view of the fact that the caecum worm, *Heterakis gallinae*, may be an intermediate host or carrier of the organism causing blackhead, the addition of tobacco dust to the ration, as described under treat-

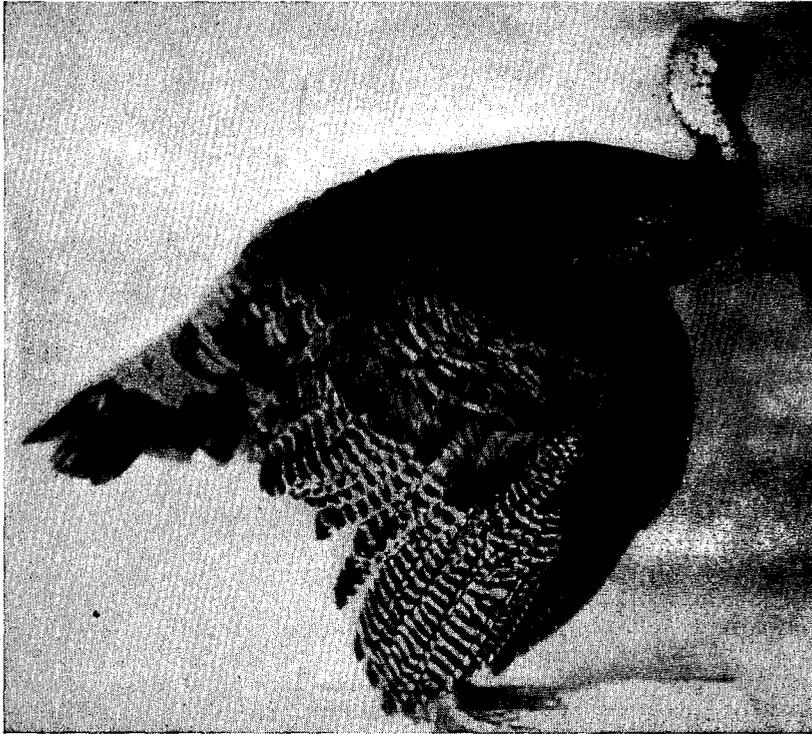


FIG. 16.—Typical position of a turkey affected with blackhead disease. (The position and the sulphur-colored droppings are usually diagnostic of blackhead.)

ment of roundworms (page 96), is distinctly beneficial if fed to growing poults from the time they are old enough to eat mash until they are ready for market.

Too much stress should not be placed on the use of drugs as curative agents. Their only value is in their tonic effect, and to date no treatment is known to be specific for blackhead and no vaccine or treatment has been found to be of value. Some of the sulfa drugs, as described under coccidiosis, have been reported of value. A drug called "Mepharsen" gives good results when used on diseased birds.

This is injected intravenously within a period of 30 seconds. It is supplied in 0.06 gram vials. Dilute with 10 ml. of water and inject into 10 birds. When injected into the tissues some sloughing occurs so that birds should not be treated within a month before marketing. Phenothiazin, 1 pound per 1,000 birds, given in wet mash has been reported as giving fairly good results in controlling cecum worms.

Remove the birds to new quarters as soon as the disease is noted, and see that all drinking and feeding vessels are thoroughly cleaned and scalded. Sick birds should be killed and burned.

As far as is known the flesh of slightly infected birds is fit for human consumption if the liver is discarded. Well birds from flocks which are suffering from blackhead should be sold for the early trade. Sick birds should not be sold. Sometimes poults that are in the first stages of the disease may fatten well and show no outward symptoms, and if such birds reach the market in that condition their food value is not lessened.

#### Management of Poults to Prevent Blackhead

Concerning the management and feeding of poults for the prevention of blackhead, Prof. L. F. Payne, of the Department of Poultry Husbandry, outlines the following system:

The most successful methods of preventing blackhead consist of artificial hatching and brooding and then rearing the young poults either in confinement or by practicing a definite rotation program.



FIG. 17.—Liver of turkey affected with blackhead showing irregular yellowish areas on the surface.

In confinement the poults are brooded in a house with a concrete or wooden floor that has been previously cleaned and thoroughly disinfected. The poults should be kept inside this brooder house until six or eight weeks old, at which time they are moved to a range that has not been frequented by chickens or sick turkeys. This brooder house must be cleaned and disinfected at least once each week. One quart of cod-liver oil must be fed with each 100 pounds of mash to prevent rickets.<sup>40</sup> Some modify this system of complete confinement by furnishing a small run in front of the brooder house. To use this modification successfully it is necessary to place an eight-inch layer of clean river gravel over the entire ground area of the run or to construct a hail-screen sanitary runway. Where such a run is used it is not necessary to feed cod-liver oil except during long periods of continued cloudy weather.

In the rotation method the brooder house is equipped with four separate pens. The young poults occupy one pen for one week only and are then ranged in a different pen. A definite order is followed so that all pens are ranged one week and remain free from turkeys for three weeks before being used again. Some turkey raisers move the brooder house each week to a new range instead of using the four-pen system. The underlying principle is to keep the young poults on clean, fresh ground all the time. These pens or ranges need not be large. The turkeys do not need a large area over which to roam if the ground is clean. Green grass or alfalfa can be cut and brought to them, and poults will not eat much more grain and mash in confinement than when allowed free range. The small additional feed cost can be considered insurance against loss from blackhead.

Considerable care must be used to avoid overfeeding, and using wet, sloppy, or spoiled feed. There is considerable leeway in the feeding of poults if the essential precautions are followed, and it seems only logical that the simplest and easiest method should be recommended.

The Department of Poultry Husbandry of the Kansas Agricultural Experiment Station has secured good results with turkeys by adopting good chick brooding practices.<sup>41</sup> The poults are placed under a brooder stove in confinement. The following directions present briefly the system used:

1. Feed immediately upon removal from incubator by spreading mash over a cupped egg flat. Hard boiled eggs broken up and spread over the mash will do much to start poults eating. Feed the eggs twice daily at the rate of one egg for each 40 poults. Stop feeding eggs the fourth or fifth day.
2. Use a wire floor or sand or gravel as a litter where solid brooder house floors are used.
3. During the first 12 weeks feed mash only. This should be before the poults at all times in open hoppers.

40. An amount equivalent to 88,500 U. S. P. Vitamin D units per 100 pounds of mash feed.

41. For specific recommendation on feeding of turkeys, the reader is referred to the Department of Poultry Husbandry at the college.

4. When 12 weeks old, a scratch grain should be hopper fed in addition to the mash.

5. Green feed, if used during the first few weeks of the brooding period, must be very tender. The feeding of stems and woody portions should be avoided to prevent impaction of the digestive tract.

6. Clean, coarse gravel should be supplied in a box to furnish grit.

7. Chick-size oyster shell should be accessible to the poults while young.

8. The poults should be continued on the mash and grain feed until ready for market.

**Trichomoniasis.**<sup>42</sup>—This disease, sometimes referred to as “Necrotic ulceration of the crop,” is due to a protozoan parasite belonging to genus *Trichomonas*. Several species have been identified and it is quite probable that they vary in different birds. This is a point which has not been determined.

The organisms are actively motile by means of three to five flagella and an undulating membrane. *T. pullorum* has been described as causing a fatal disease of baby chicks, and *T. diversa* as the causative agent for the disease in turkeys. Several other species have likewise been described from other birds. Certain types appear to be confined to the anterior (crop) and others to the lower intestine (ceca).

#### Symptoms

The symptoms are those of a catarrhal or diphtheritic inflammation of the mouth, esophagus, crop, and proventriculus. The birds sit with closed eyes, the feathers are ruffled, the appetite is lost. There is loss of weight and diarrhea is common in the terminal stages. In young chicks of two weeks of age the losses are very severe. The disease is common in young turkeys of all ages and may affect older birds.

The post-mortem of chicks which have died is not characteristic although loss of weight, and leg weakness are frequently observed. Crop involvement is not common in chickens. In the turkey the symptoms are a general unthrifty appearance with darkened heads and sunken sinuses. The chest has a depressed appearance. There is lack of appetite and drooling from the mouth and a foul odor is evident. There is usually no diarrhea when the infection is localized in the crop. A yellow foamy diarrhea is frequently observed when the ceca are involved. The lesions in the turkey are quite characteristic, especially in the crop. Here there is severe inflammation of the crop wall followed by the formation of peculiar grayish or yellowish ulcerlike areas with a concave base and elevated center of one-fourth inch or more in diameter. These are firmly adherent to the membranes. This condition interferes with the proper function of this organ.

42. The term “flagellosis” is sometimes given to the presence of any type of flagellate in the intestine. This would include both *Trichomoniasis* and *Hexamitiasis*.

**Control**

The disease may be controlled without much difficulty by sanitation. Young chicks and poults should not be allowed in the same runs with adults. Birds should not be allowed on wet areas in grain fields where matted weeds and straw are on the ground. Old wet strawstacks and wet straw litter are to be avoided. The feeding of sour milk has been recommended.

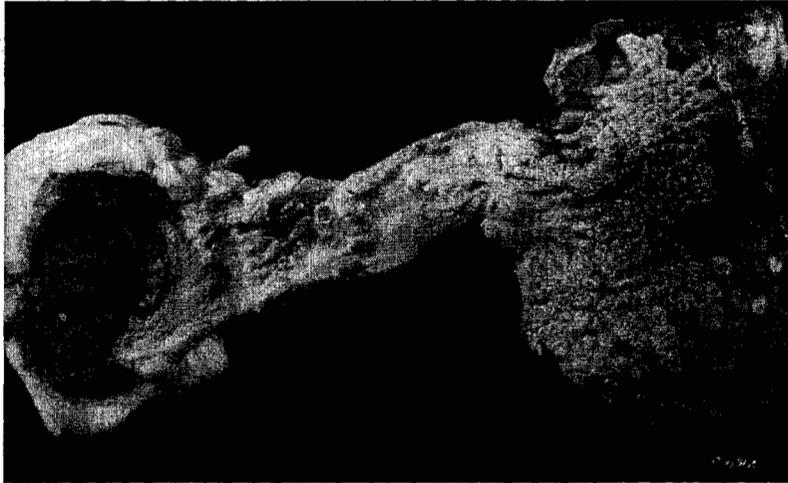


FIG. 18.—Showing trichomonas infection of the crop and proventriculus of the turkey. Note area of ulceration.

Knight, McDougle and Durant<sup>43</sup> suggest the following flock treatment with a feed containing a high percent of vitamin A, which has proved successful in controlling the disease in a high percent of cases, is prepared as follows: Two pounds of baker's yeast, or other forms of live yeast, are added to 100 pounds of ground whole oats. This mixture is placed in a 50-gallon barrel (either wooden or metal) and enough water added to form a paste having the consistency of molasses. This mixture is placed in a warm place and allowed to ferment over night (twelve to fifteen hours). At the end of this time five pints of high-grade cod-liver oil, or one pint of high biological assayed fish oil (3,000 international units of vitamin A per gram), or an equivalent of vitamin A powder, are added to the fermented paste and mixed thoroughly. The mash is then fed in troughs to poults, all they will consume in 20 or 30 minutes. Rinse the troughs with clean water after each feeding to control flies. Feed this mash three or four times a day for a week or ten days or until the poults show a marked improvement. Keep the regular starting

43. D. R. Knight, H. C. McDougle, and A. J. Durant. Trichomoniasis of turkeys. University of Missouri. Bulletin 456. 1942.

or growing mash before the poults at all times. Never ferment more mash at a time than will be consumed by the poults in one day. If the poults do not relish the fermented mash it has been suggested that enough dehydrated alfalfa leaf meal be added to make a crumbly mixture. The addition of the alfalfa leaf meal seems to increase the palatability of the mash for the birds in some of the affected flocks.

We have found that a copper sulphate solution (1 to 2,000) in place of the drinking water is of some value. This should be kept before the birds for two weeks after the outbreak starts. Sanitation is necessary to reduce the amount of reinfection.

**Hexamitiasis.**—This condition is known as “Infectious Catarrhal Enteritis.” Until recently it was considered to be due to the *Trichomonas* but has been found to be due to another protozoan parasite, the *Hexamita meleagridis*. This organism is oval in shape and rapidly motile by means of long flagella.

#### Symptoms

The poults are quite nervous and require more heat than usual. The temperature may be slightly subnormal. A foamy, yellowish, watery diarrhea is always observed. The appetite remains good but the loss of weight is rapid. The bird may die quickly, or live for long periods of time as a carrier without apparent injury.

The upper intestine may show a catarrhal inflammation. The lumen of the intestine is usually filled with a thick, sometimes foamy, exudate. The diagnosis usually depends on finding the organisms by microscopic examination. In advanced cases young birds frequently show a leg weakness and are unable to stand.

#### Control

Control depends on preventing the spread of the parasite from carriers and infected birds to normal birds. Certain birds become permanent carriers and harbor the infection from one season to the next. This cycle can be broken only by careful sanitation. Young birds should be kept away from old birds and preferably on cement yards or screen wire. Hinshaw has recommended the sale of the old breeders before poults are hatched. All dead birds should be removed and burned. Drinking utensils should be scalded each morning and the water changed twice each day. No drug treatment has been found to be effective and many are harmful. Birds must be kept away from wet runs and wet litter should be changed and floors disinfected.

## DISEASES DUE TO METAZOAN PARASITES

Under this heading will be discussed those parasites which belong to the animal kingdom and which are more complex in structure than the simple unicellular fungi and protozoa. The classification of this group is very difficult. Authorities sometimes group them according to appearance, at other times according to the location on the host.

Such parasites are particularly injurious to young stock. Although death losses are not usually high, the birds are stunted and production is lowered. Heavily parasitized birds are prone to be irritable, to develop vicious habits, and are more susceptible to bacterial infections than nonparasitized birds.

The important parasites belong to two groups, the *Arthropoda*, including lice, mites, ticks, fleas, flies, etc.; and the *Vermes*, including large and small roundworms, tapeworms, and flukes.

They may injure birds in several ways—

1. Mechanical injury caused by biting (lice, flies, fleas, etc.)
2. Irritation caused by crawling (lice).
3. Competition with the host for food (worms).
4. Removal of blood (mites, ticks, flies, mosquitoes).
5. Transfer of microorganisms (fleas and flies).
6. Formation of toxic products (worms).

## DISEASES DUE TO LICE AND MITES

There are numerous minute insects similar to the common chicken mite which attack various domesticated birds. Each species is different in its action and is described separately. All are quite harmful.

*Mites (Common Chicken Mites).*—There are few poultrymen who do not know the ravages caused by the common chicken mite, *Dermanyssus gallinae*. It is very common all over the United States and especially in the South and Southwest. It is more prevalent in midsummer, but as it lives from four to five months, infestations are common in the fall and winter. Although dampness seems to increase the length of life of the mite, hot, dry weather is essential for its maximum development.

This mite is just visible to the naked eye, is grayish in color except when engorged with blood. It is a bloodsucker that remains on the body of the host until engorged and then returns to its hiding place—in cracks of roosts and floors, in refuse, and other obscure places.

Eggs are laid in cracks and hatch in about two days. The adult stage is reached in about eight days. The rate of development depends somewhat upon the temperature.

### Symptoms

Mites cause severe irritation to the host, but seldom leave any mark. Unthriftiness, anemia, pale comb, and decrease in egg production are results of their action. Setting hens often leave the

nests as a result of a severe infestation. Very few mites remain on the birds during the day, for mites are essentially night workers and hunt their hiding places in the daytime. Careful examination of cracks, dropping boards and nests will often reveal large numbers of them.

#### Control

Removal of all interior fixtures and thorough disinfection with a strong dip or wood preservative applied with a force pump is recommended. All rubbish should be removed and burned. Care must be taken to get the spray into all crevices. Kerosene emulsion or crude petroleum, and wood preservatives may be used for spraying, followed by whitewash. Whitewash aids mechanically in filling up many crevices. Spraying should be repeated after one week to get any mites that escape, and it may be well to give a third treatment.

Roosts, walls, and supports should be painted once each year with carbolineum. A treatment of roosts, nests, boxes, etc., each spring with undiluted carbolineum, crude carbolic acid, creosote oil, or sheep dip is usually sufficient to reduce the action of mites to a minimum. The fact should be kept in mind that mites are blood-sucking parasites and do not remain on the bird as do lice. Mites are much more harmful to poultry than lice and it is necessary to treat the house and not the bird as in the case of lice.

Construction of roosts and nesting places so as to reduce hiding places to a minimum is an excellent control measure. Proper construction and the use of sprays will keep down this pest.

New birds brought to the farm, or birds moved to new quarters, should be isolated for a few days in a pen separate from the permanent quarters, so that all mites will leave them, thus preventing infestation of the new quarters. If the birds are moved during the day rather than at night, mites will not be carried with them. They may be introduced on crates and grain and feed sacks which are transferred from farm to farm.

Other precautions to bear in mind are the possibilities of persons, pigeons or wild birds carrying the mites to clean quarters. By being careful to guard against these sources of infestation the chance of mites invading the houses will be minimized.

**Mites (Scaly Leg).**—Scaly leg is caused by a small mite, *Cnemidocoptes mutans*, which burrows into the skin of the feet and legs, causing an injury from which an exudate oozes. This exudate dries and causes the scaly condition from which it derives its name. It generally appears between the toes and works upwards, finally involving the unfeathered parts of the leg. In bad cases, the leg may appear many times its normal size.

#### Control

Combine the "clean-up" measures with local applications of an ointment consisting of oil of caraway, one part, and vaseline, five parts. Equal parts of kerosene and olive oil well rubbed in is also very good. Apply on several successive days. Local application

without general cleaning is of no avail because the mites often leave the affected bird and will attack other birds if not destroyed.

**Mites (Air Sac).**—The air sac mite, *Cytoleichus nudus*, is found to some extent in this state and is important in that an infestation may be confused with tuberculosis. The mite is small, yellow, and soft bodied, barely visible to the naked eye. It may be found in any of the air passages, but most often on the linings of the air sacs. It has also been reported in the liver, heart, and kidneys.

#### Symptoms

Unless present in very large numbers, air sac mites do not seem to affect the bird. In heavy infestations, symptoms resembling those of tuberculosis are noticed such as unthriftness, "going light," paleness of the head, and dryness of feathers.

#### Control

Treatment is useless, owing to the fact that the mites are located in areas that cannot be reached with drugs. The affected birds should be killed and burned, and sanitary measures practiced to aid in prevention of an infestation of other birds.

**Mites (Harvest, Chiggers, "Red Rugs").**—Chiggers, or harvest mites, affect young birds especially, but may be found on those of any age. Chickens on free range are most susceptible. This is the same mite that attacks man. The chigger is the first stage in the life history of a red mite, genus *Trombicula*, that is harmless when mature.

#### Symptoms

Chiggers attack the body of the chick, under the wing, on the breast, and on the neck, causing suppurative abscesses similar to those found in the skin of man. These abscesses are reddish in appearance and may attain a diameter of one-third inch. The affected bird becomes droopy and emaciated, and intense itching of the part where the chiggers are feeding is noticeable, as indicated by the nervous action of the bird.

#### Control

Prevention consists in keeping the birds away from infested ranges, and raising early spring chicks that will be beyond the stage of susceptibility before the chiggers reach the stage at which they attack the birds. Occasional dusting with flowers of sulphur will tend to keep the mite from infesting the chicks. Fenced-in ranges may also be dusted with very finely ground sulphur with a dust blower at the rate of fifty pounds per acre. Treatment of affected birds consists in removing the scab and washing out the suppurating area with a 5 percent carbolic acid solution or a 2 percent solution of silver nitrate. Tincture of iodine should then be applied to each abscess.

**Mites (Northern Fowl).**—This mite (*Liponyssus silviarum*), is a serious pest of poultry and has recently become widely spread over

this country. Poultry shows, as well as poultry traffic in general, have been the most important factors in their spread. However, wild birds, animals, and man may carry these mites from infested to previously free premises. Unlike the red mite, this mite lays its eggs on the fowl and spends its entire life on the bird, although when present in large numbers they may be found in nests and on perches. The mites are often found on loose feathers on the floors and dropping boards.

These mites, like the red mite, are bloodsuckers and cause severe irritation and rapid loss of flesh. Egg production and growth are naturally very seriously impaired.<sup>44</sup>

**Mites (Other).**—Several other mites of lesser importance infest chickens. The depluming mite, *Cnemidocoptes gallinae*, burrows beneath the skin at the base of the feathers. It causes severe itching and is often the cause of feather pulling in birds.

Another mite, *Rivoltasia bifurcata*, feeds directly on the feathers but causes little injury.

A connective tissue mite, *Laminosioptes cysticola*, burrows just beneath the skin, where it causes small yellowish nodules to form.

Of interest to turkey raisers is a small mite, *Freyana chanayi*, that has not yet been reported in Kansas, but which is prevalent in Texas and Louisiana. It locates itself along the grooves on the under side of the shaft of the wing feathers.

Cleanliness combined with local treatment with sulphur ointment will usually aid in controlling outbreaks of mites. Treatment of the perches with Black Leaf 40 is also recommended.

**Lice.**—Lice are a more important factor in poultry raising than is often supposed, for a bad infestation may so lower the resistance of a flock that serious losses will result. They are also an important factor to be considered when treating other diseases, for a bird with lowered resistance, due to lice, will not respond readily to control measures being used for other diseases. However, lice are much less harmful than mites, since the latter are bloodsucking parasites while the former are of importance more because of their irritating action due to their constant movements. They act somewhat as scavengers, living on the dead portions of the skin and feathers.

Lice may be found on almost any part of the body and are named after the part affected—neck lice, wing lice, body lice, etc. Several species are commonly found on chickens of the United States, and a single bird may be infested with two or three of these at the same time.

#### Control

Lice will not trouble the poultryman who practices the “clean-up measures” previously outlined. At the present time sodium fluosilicate or sodium fluoride seems to be the best general remedy. Bishopp

44. Payne has recommended the use of Black Leaf 40 for the control of these parasites. This product is painted on the perches and supports about 20 minutes before the birds go to roost. Three applications in three days should completely eradicate the mites. Proceedings 21st Annual Meeting, Poultry Science Association, Auburn, Alabama. 1929.

and Wood recommend dipping the birds in a solution of these chemicals as follows: The dip is made in a tub in the proportion of one ounce of the powder to each gallon of water. The bird is held by the wings with one hand and submerged in the solution; the other hand is used to ruffle the feathers and wet the body. Finally, duck the head of the bird a few times, drain for a few seconds, and release. One pound will be enough to treat 300 hens when using the dip method.

Since it is unsafe to practice dipping except in warm weather, the "pinch" system of treatment is also used and gives excellent results.<sup>45</sup> A pinch of sodium fluosilicate or sodium fluoride is taken between the thumb and forefinger and placed on all affected parts—under the wings, on the head, on the back, on the breast and under the tail. The feathers are then ruffled through the fingers to spread the powder. The fowl may be placed in a shallow pan so that all surplus powder can be recovered. If many birds are to be treated the operator's eyes and nostrils should be protected, for the drug is somewhat irritating. One pound will treat 100 birds when the pinch method is used.

These powders may be diluted by mixing one part of the drug with four parts of talc, road dust, or other finely divided material. When so diluted it can be applied with a sifter-top can similar to one used as a salt shaker.

Black Leaf 40 has recently been used with good success as another treatment against lice and mites. This method eliminates the extra time and labor of handling each individual bird.

This is applied to the perches in a very thin line by means of a small brush or by pouring out of a vessel with a very small opening. About 8 ounces per 100 feet are required. The material should be applied 20 or 30 minutes before the birds go to roost. If the perches are filled with grease, from previous applications of crankcase oil it may be necessary to scrape the upper surface slightly to make the various solutions remain in place. The warmth of the body of the bird causes the nicotine to volatilize and as the vapor rises it reaches all the surfaces of the body of the bird, particularly the base of the feathers where the lice are most numerous. The lice are killed, except those on the head and neck, within a short time and drop to the floor.

One treatment may be sufficient, but if on an examination of a representative number of birds three days after treatment lice are still present, the treatment may be repeated. Reinfestation with newly hatched lice may require a second treatment. Birds that do not reach the treated perches may be treated by placing them in a nest or small coop in which a small amount of Black Leaf 40 has been placed. For the northern fowl mite at least three treatments are necessary.

Great care must be exercised in using products containing nicotine

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45. A special grade of light fluffy powder should be selected for this purpose.

sulphate because of the poisonous effects on animals and man. If any of the material reaches the clothing or skin of the operator it should be washed off at once to prevent absorption.

Orthophenylphenol, one-fifth of a pound per gallon of kerosene, can be sprayed over the roosts or mixed with talcum or fuller's earth and used as a powder. Dusting with phenothiazine has also been recommended. The United States Department of Agriculture recommends the use of 10 pounds of wettable sulphur per 100 gallons of water for dipping ducks to control lice. This should be repeated after ten days. DDT should be satisfactory for this purpose whenever it becomes available.

**Ticks.**—The fowl tick, *Argas persicus*, is not found in Kansas, since it is essentially a native of hot, arid or semiarid areas where the winters are mild. In the United States its distribution is limited to an area from southwestern Texas, westward along the southern part of New Mexico, Arizona, and California, where it is known as the "blue bug" or "adobe tick." It has been reported to attack most types of domesticated birds as well as canaries and wild birds. Occasionally it finds its way to more northern areas and may live for a short time, but seldom long enough to cause severe injury. Certain species of ticks in the tropics transmit the organism of fowl spirochaetosis (*Borrelia gallinarum*). In Europe there are "the pigeon tick," *Argas reflexus*, and other species which parasitize pigeons.

This tick passes part of its life on the fowl, feeding mainly at night when in the nymph stage, and living in crevices and cracks during the day. Unlike most other ticks, the adult female does not die after depositing eggs, often laying as many as seven different times before death.

The fowl tick is most difficult to combat, and usually complete destruction of the henhouse by burning is necessary to control an infestation.<sup>46</sup> Birds should not be allowed to roost in trees infested with these ticks because the insects appear to live there for many months. Birds should be moved to new places during the daytime, since the ticks are on the birds only at night. Since the ticks tend to crawl up, rather than down, the suspending of the perches from the ceiling by means of wires will protect the birds at night. Although we have not had experience in its use for tick control, it appears that Black Leaf 40 should be of value.<sup>46</sup> In Farmers' Bulletin 1652, 1936, a thorough treatment of the walls, supports, and perches at intervals of three or four weeks with anthracene oil is recommended.

<sup>46</sup>. Bishopp, F. C., and Wagner, R. D. Nicotine in the control of Ectoparasites of poultry. Jour. Econ. Ent. 24, p. 66. 1931.

## DISEASES DUE TO WORMS

There is probably no group of parasites so injurious to poultry as worms. In most instances the action of these parasites is not well understood. Some appear to injure the bird because of mechanical action, or interference with some physiological function, while others seem to be somewhat toxic. Very few, however, cause such acute injury as that observed from the action of bacteria and protozoa. In many instances their action is so insidious as to pass unobserved until the birds are seriously injured. In addition to this it is very difficult to treat worm infestations successfully without, at the same time, doing considerable harm to the birds. They are usually classed as internal parasites, since none are found on the outside of the body.

Since the various worms are quite different in their action and location in the intestine, no general type of treatment can be recommended. This is especially true of roundworms and tapeworms. A combination treatment for the removal of both at the same time is not recommended.

**Manson's Eye Worm.**—Eye disease due to the parasite (*Oxy-spirura masoni*) is common in the southern portion of the country, but has not been reported in Kansas.

The worm is not transmitted by contact, or by feeding the worm eggs, but appears to require residence in the body of a cockroach (*Pycnoscelus surinamensis* Linn). Sanders<sup>47</sup> has found the larvae imbedded in the adipose tissue and free in the body cavity of those roaches. The worm larvae are freed in the crop of the bird and migrate up the esophagus to the mouth, passing through the nasolachrymal duct from whence they may reach the eye within twenty minutes after the roach is eaten. Here the worms reach sexual maturity and lay eggs which reach the intestines and pass out in the droppings. In this manner they are placed within reach of the roaches which are common in poultry yards.

### Symptoms

The worms are located under the nictitating membrane (thin membrane). Here they may set up an inflammation. The bird scratches the eye, thus leading to injury and severe ophthalmia. During this stage of the disease the worms leave the eye and conditions develop which cannot be distinguished from ordinary ocular roup.

### Control

Since the cockroach becomes infested with these worm larvae from consuming eggs in the droppings of birds which carry the adult worm, a daily removal of droppings will eliminate the most serious source of trouble. Runs that are clean, free from trash, loose boards,

47. Sanders, D. A. Manson's eye worm of poultry. Jour. Amer. Vet. Med. Assoc. Vol. 25 (n. s.), No. 5, pp. 568-584. Feb., 1928.

and mudholes, and exposed to the sun will drive the cockroaches to seek a more congenial location and thus take them away from the birds.

The birds may be freed of worms by carefully lifting the membrane covering the eyeball and introducing a drop or two of 2 percent cresol solution daily for a few days. A drop of 5 percent creolin has been recommended to kill the worms immediately, but must be removed at once by irrigating the eye with water.

Since most common wild birds which frequent poultry yards are easily infested by the worms they may act as carriers and spread the worm from farm to farm. These birds should be kept out of poultry houses as much as possible. Sanitary premises and self-feeders will prevent their frequenting the runs in large numbers.

**Gapes.**—Gapes is a disease of young fowls caused by a small, reddish worm, *Syngamus trachea*, which attaches itself to the mucosa (inner lining) of the trachea (windpipe). It is often called a forked worm because the male and female are firmly attached to each other at an angle that gives them the appearance of a single branched worm. The presence of the worms may be demonstrated by passing an extractor consisting of a loop of fine wire or a horse hair down the trachea for a short distance and turning it to loosen the worms. If present they may then be drawn out in considerable numbers.

#### Symptoms

The worms cause a severe inflammation, suck blood, and may result in asphyxia if present in large numbers. The affected chick gapes, sneezes, and becomes pale and weak. Loss of appetite followed by emaciation is noticed. Spontaneous recovery is rare, and heavy mortality results where treatment is lacking.

#### Control

Stripping a feather of all its web, except a small tuft on the end, moistening this in kerosene and inserting it into the windpipe where the worms are attached will often cause them to loosen their hold. They can then be withdrawn or coughed up. However, this method is not reliable in all cases, for some of the worms may be out of reach. Garlic oil, or the synthetic product, allyl sulphide, may be used with success. This is given by forced feeding with a pipette in doses of about 3 drops of a 33 percent solution in linseed oil. Within three days the parasites are loosened and coughed up.

The United States Bureau of Animal Industry has recently developed a new treatment using barium antimonyl tartrate. The birds are placed in a box and one ounce of the powder is added for each 8 cubic feet. The box is tilted from side to side and the birds are allowed to inhale the dust for 15 to 20 minutes. This treatment is said to be very effective. Reliance must be placed in prevention. In badly infested pens kill and burn all stock, clean buildings, runs, and premises. Allow the ground to rest for six months. Under conditions where land is not available it is advisable to treat this

ground with air-slacked lime and spade carefully. The spading is the more effective method of control.

Rotation of runs, frequent changes of litter and a continuous supply of fresh water will do much to prevent gapes. Chicks should not be kept on land with turkeys, or where turkeys have been running during the previous year. Turkeys of all ages may harbor this worm without being seriously injured by it. Many wild birds likewise serve as carriers.

**Capillaria.**—The capillaria are very slender, hair-like roundworms about one-half to three-fourths of an inch in length, which are common parasites in the intestinal tract of birds, chiefly in the wall of the crop. Because of their small size they are usually overlooked unless a specific search is made for them.<sup>48</sup> There are several species. They have been reported from the chicken, turkey, pheasant, pigeon, duck, goose, and several wild birds. *Capillaria annulata*, *C. longicollis*, and *C. contorta* have been reported. The former is known to require an intermediate host (earth worm), in the latter no intermediate host is required. The worms penetrate into the lower levels of the lining membrane and cause thickening and sometimes a congestion and inflammation, when large numbers are present.

#### Symptoms

In most instances the only symptoms are an unthrifty appearance, weakness, and loss of weight. In chronic conditions a catarrhal inflammation develops, the function of the crop is impaired and the contents may become putrid.

#### Control

The life cycle of some of these worms is direct and the eggs require some time in a moist soil before the embryos mature to a stage at which they can establish themselves in the intestine of new birds; others require an intermediate host. These facts indicate the necessity of a careful sanitary program to prevent the constant spread of the worm eggs. Wet runs are to be carefully avoided.

The use of tobacco dust, 2 pounds, containing not less than 1.5 percent or more than 2.5 percent nicotine, to each 100 pounds of dry mash, has been recommended. Feed daily for three weeks, discontinue for two weeks and repeat for a similar period.<sup>49</sup>

Carbon tetrachloride in 1.0ml. doses, has been found effective for certain kinds of capillaria. This dose should be repeated twice at 10-day intervals.<sup>50</sup>

**Gizzard Worms.**—A number of very small roundworms have been found in the lower esophagus, proventriculus, and gizzard

48. The best method of demonstrating these parasites in the walls of the crop is to stretch it over an electric light bulb and examine carefully.

49. It has been estimated that tobacco dust will lose 14 percent of its nicotine content each month it is exposed to the air. For this reason it should be sealed in air-tight containers until used. When mixed in mash and exposed to the air it rapidly deteriorates and soon becomes useless.

50. See page 96 under Roundworms.

which are commonly grouped under the term "gizzard worms." The *Cheilospirura hamulosa* is reported from the chicken and turkey, and *Amidostomum anseris* from ducks and geese. Other forms are recognized in other birds.

The parasites of the chicken penetrate beneath the horny membrane lining of the gizzard and bury themselves in the muscles. The lining becomes loosened and a nodular condition is occasionally observed on the surface of the organ. The worms vary from one-fourth to three-fourths of an inch in length.

Some of the worms are known to have certain species of grasshoppers as intermediate hosts. The larvae hatch in the intestine of the grasshopper and penetrate its muscles where they develop to a stage at which they are able to invade the tissues of the second host. These larvae are later set free in the digestive tract of the fowl. However, the life cycle for the *Amidostomum* is direct, the birds becoming infested after ingestion of the eggs containing matured embryos.

The parasite in the duck is somewhat different from that in the chicken, although the symptoms and post-mortem findings are similar.

#### Symptoms

The symptoms are not marked except for some general unthriftiness and evidence of disturbed nutrition. On post-mortem examination the parasites are brought into evidence by stripping off the lining of the proventriculus or gizzard. In most instances the areas occupied by the worms are located by the appearance of rough, brownish areas of the lining.

#### Control

Since the parasite of the chicken passes through an intermediate host which has become parasitized by eating the worm eggs they will be protected by the careful removal of droppings. In the case of ducks and geese, the problem is not so easy, since these birds frequent bodies of water and lowlands where sanitation is very difficult.

Carbon tetrachloride and tetrachlorethylene in 1.5 to 2.0 ml. amounts has been recommended for adult birds. Continuous feeding of tobacco dust at the rate of 1 percent of the mash should be of value. Frequent change of runs, careful removal of litter, and the use of sanitary drinking fountains will aid in reducing the losses.

**Stomach Worms.**—Two other groups of worms are of some importance in the chicken and certain game birds. These are the so-called "spiral" stomach worms, *Dispharynx spiralis*, and the chicken stomach worm, *Tetrameres americana*. The former passes a part of its life in the body of a sowbug, in which it remains for about four weeks and if eaten by a chicken infests the proventriculus, where it causes severe injury.

The *Tetrameres* also inhabit the proventriculus. Grasshoppers and cockroaches have been found to be intermediate hosts. This parasite invades the deeper layers of the gland where it grows to

maturity. The body of the female worm becomes greatly distended with eggs, and assumes a globular shape and a bright red color. The males retain their slender form.

#### Symptoms

The usual symptoms are an unthrifty appearance, emaciation in spite of increased appetite, and occasionally death of the bird.

#### Control

No specific treatment is known, although tobacco dust, carbon tetrachloride, and tetrachlorethylene have been recommended as of some value. The use of soft feeds rather than hard grain will reduce the mechanical injury to the injured membranes. Daily removal of the droppings will keep the eggs away from the intermediate hosts.

**Roundworms.**—Two other important species of roundworms are common in Kansas chickens. The large roundworm, *Ascaridia galli* (Fig. 19), is the one most often found in the small intestines from the duodenum to the ceca (blind pouches). It is a white or yellowish worm attaining a length of one to four inches in the adult stage and may be found at times in such large numbers as to fill the lumen of the intestine.

The other roundworm is that commonly known as the cecum worm, *Heterakis gallinae*. It is very small (one-fourth inch long), white, and is found in the ceca. It may be present in numbers large enough to cause severe irritation to the lining of these organs. Some investigators consider its presence in turkeys a factor in the spread of the blackhead organisms.

Ackert<sup>51</sup> has found that if the birds have reached the age of three months before the large roundworm of the intestine becomes fully established, the worms do not cause such a severe disturbance as when the infestation occurs early in the life of the bird. No intermediate host appears to be necessary for these worms. The young larvae penetrate deep into the mucous membrane of the cecum.<sup>52</sup>

#### Symptoms

Chickens may be heavily infested with roundworms before any abnormality is noticed. Young birds are most commonly infested and show general unthriftiness, drooping or sagging of the wings, paleness of the head, and emaciation, but loss of appetite only in advanced stages. Birds kept in crowded quarters or in damp, poorly drained runs and kept on feeds low in vitamins seem more susceptible to the action of the roundworms. Diarrhea or the other extreme, constipation, may be present. Careful post-mortem examination of the intestines of a bird dead with the infestation will reveal the presence of the worms.

51. Ackert, J. E. Natural resistance to helminthic infection. Jour. Parasitology Vol. 28:1-24. 1942.

52. A similar parasite *Heterakis isolonche* penetrates deep into the mucus membrane of the ceca of pheasants where it forms nodules and gives rise to a condition known as typhlitis.

**Control**

The California Agricultural Experiment Station recommends the following treatment for roundworms: Mix two pounds<sup>53</sup> of tobacco dust, containing not less than 1.5 percent nor more than 2.5 percent nicotine, with 100 pounds of dry mash. Feed this daily for three weeks, and after discontinuing for two weeks repeat the treatment for a similar period. Some practical feeders keep this before the birds continually. Epsom salt should be given at the rate of one pound per one hundred full-grown birds after the first week and at the end of each period.

The Epsom salt treatment for each 100 birds may be given by placing 1 pound of the salt in 3 gallons of water. This should be supplied as the only source of drinking water from seven o'clock in the morning until eleven o'clock. The solution is then removed and the birds are given fresh water.

When possible the birds should be shut in the coops during the treatment and for at least twenty-four hours following the giving of Epsom salt. All droppings should then be removed and burned in order to destroy the eggs. Yards should likewise be thoroughly cleaned and the refuse burned or hauled to areas not traversed by the flock. These precautions are necessary, since reinfestation can easily occur by the birds picking up the worm eggs from the droppings. Where the tobacco dust treatment is given over a period of two weeks or more it is not advisable to shut the fowls up during treatment, but the runs and the coops must be cleaned frequently, thus minimizing the danger of reinfestation.

Graybill and Beach<sup>54</sup> have recommended the use of carbon tetrachloride for the cecum worm and large roundworms. It is most conveniently and safely administered in 1 ml. gelatin capsules. The dose for an adult bird is 3 ml. They found that the rectal injection of from 5 to 15 ml. gave approximately 60 percent efficiency in removal of cecum worms, with complete failure in some cases.

Freeborn<sup>55</sup> stated that nicotine sulphate mixed with fuller's earth (Lloyd's alkaloidal reagent) was effective and not poisonous since the nicotine was not liberated until it reached the small intestines. The mixture of nicotine sulphate (40 percent nicotine) at the rate of 6.6 ml. (7.92 grams) to 16 grams of the earth placed in 55 No. 2 capsules and given at the rate of 1 capsule per bird has given good results. GREAT CARE MUST BE USED IN GIVING NICOTINE SULPHATE BECAUSE OF ITS HIGH TOXICITY.

Hall and Shillinger<sup>56</sup> recommend oil of chenopodium and olive oil injected into the ceca, via the rectum, to control cecum worms,

53. This amount should be increased about one-half in case of capillaria or gizzard worms.

54. Graybill, H. W., and Beach, J. R. Anthelmintic treatment for the removal of heterakids in fowls. *The Cornell Vet.* Vol. 15, No. 1, pp. 21-36. Jan., 1925.

55. Freeborn, S. B. Nicotine as a poultry vermifuge. *Science.* Vol. 57, No. 1485, p. 692. June 15, 1923.

56. Hall, M. C., and Shillinger, J. E. The removal of heterakids from the ceca of chickens by rectal injections of anthelmintics. *Jour. Am. Vet. Med. Assoc.* Vol. 62, pp. 623-630. 1923.

*Heterakis gallinae*. This treatment will remove about 90 percent of the worms, and if repeated occasionally will aid greatly as a control measure if sanitary precautions are practiced at the same time. They advise the use of one dram of oil of Chenopodium (1 teaspoonful) to six fluid ounces of olive oil or cottonseed oil, given at the rate of one-third of an ounce to a bird weighing three pounds or more, regulating the dose according to the weight of the bird. The two drugs should be thoroughly mixed and given with a small, hard rubber enema syringe. The syringe inserted into the vent shall follow the lower floor of the cloaca (the common passage into which open the rectum and oviduct). When the rectum is reached the tip of the syringe should be passed into this organ and the solution injected slowly. This procedure is as easy as giving treatment by mouth, and can be given just as quickly.



FIG. 19.—Roundworm parasites (*Ascaridia galli*) from small intestines of a chicken.

Another treatment which may be used with success is a mixture of equal parts of turpentine and cottonseed oil. Each bird should be given 4 ml. of this mixture by mouth before the morning feed.

Phenothiazine in doses ranging up to 0.5 grams per bird has been reported to give an 80- to 100-percent efficiency in removing cecum worms.<sup>57</sup>

Many other treatments have been recommended, but the above seem to give the best results at the present time. It must be remembered, however, that no treatment will be successful if given without heeding proper sanitary precautions. Frequent cleaning of runs and houses, burning of all refuse to insure death of larvae and destruction of worm eggs, and keeping stagnant pools well

57. McCoullough, E. C., and Nicholson, L. G. 1940. Phenothiazine for the removal of *Heterakis gallinae* from chickens. *Vet. Med.*, Vol. 35.

drained are as important as giving of anthelmintics to rid the flock of worms. When possible, frequent changing of runs will aid in controlling roundworm infestation.<sup>58 59</sup>

Since the embryos do not mature as long as the worm eggs are kept dry, one important method of control is to keep the runs dry and the drinking vessels well protected from droppings. Young birds are most susceptible and should not be placed with old birds. Since worm eggs cannot be destroyed by adding disinfectants to the drinking water, it is necessary to scald the water vessels each morning with boiling water.

**Tapeworms.**—Tapeworms are white, flat worms made up of a number of segments that give them a jointed appearance. Many species are found, and more than one may be present in the same bird. One of these, *Raillietina echinobothrida*, causes a nodular condition of the intestines that resembles tuberculosis. In the adult stage it can readily be recognized with the naked eye. In contrast to this species are others, *Amoebotaenia sphenoides* (2 or 4 mm. long) and *Davainae proglottina* (1 to 2 mm. long), which are often overlooked upon a post-mortem examination because of their minute size. It is advisable therefore to examine organs in a good light.

The *Raillietina cesticillus* (10 to 50 mm. long by 2 mm. broad); *Raillietina tetragonu* (10 to 250 mm. long by 1 to 4 mm. broad); the *Hymemolepis carioca* (30 to 80 mm. long by 0.5 mm. broad) are some of the more common large tapeworms of the chicken. They are also found in other species of birds. These forms have beetles, earthworms, houseflies, etc., as recognized intermediate hosts.<sup>60</sup>

### Symptoms

The symptoms of tapeworm infestation in birds (Fig. 20) resemble those shown by birds infested with roundworms, and in addition nervous conditions are often noticed. Wryneck is common, and the bird in this condition often continually holds its head to one side, or straight back over the body. A twitching of the head may be noticed and a loss of equilibrium will often be seen. When the bird attempts to walk it will fall forward on its head as if to take a somersault. Ducklike attitudes are common, and one bird sent to this laboratory assumed a typical penguin-like posture. Lameness and paralysis are also characteristic in severe outbreaks. Young birds heavily infested with tapeworms do not develop feathers properly, and late chicks may be severely sunburned as a result.

58. For additional details see U. S. Dept. of Agr. Farmers' Bul. 1652, Diseases of poultry, 1936.

59. On page 102 is described the iodine treatment which has been found to be so successful by Chandler in Michigan.

60. The tapeworms of fowls require an intermediate host for the development of their larval stage. When this host animal is swallowed by the chicken the larval tapeworm is set free in the chicken's intestines where it grows rapidly into an adult tapeworm. Thus one tapeworm is transmitted from one chicken to another by a snail, another by the biting stable fly, and three chicken tapeworms are transmitted by the common housefly; other tapeworms have other intermediate hosts.



FIG. 20.—(A) A chick three months old heavily infested with tapeworms. (B) Portion of the intestines of a chick.

### Control

Unlike the case of roundworms, preventing the birds from picking up eggs from the droppings will not prevent them from becoming infested, for the egg has to be taken up by flies or other forms of intermediate hosts before it can be a source of danger to the fowl. It is impractical to prevent birds from eating insects, so preventive measures must be taken against flies and other intermediate hosts getting the tapeworm eggs. Control measures will be greatly aided by careful removal of droppings and refuse from houses and runs. At least the droppings should be hauled to a remote area of the farm that is not frequented by the chickens. All the measures given for control of roundworms should be practiced. Wolfenbarger and Hoffmann<sup>61</sup> report the successful use of a 2 percent solution of DDT (dichloro-diphenyl-trichlorethane) in deodorized kerosene for the control of flies. The material was sprayed on the walls and over the droppings.

There is no satisfactory method of treating birds for tapeworms. The heads of the worms are buried so deeply in the mucosa that the ordinary treatment will not reach them. It must be expected that any successful removal of worm heads will seriously injure the bird at the same time. Prevention is much more satisfactory than attempts to remove the worms. Since most poultrymen do not prevent infestation, a few of the treatments most commonly recommended are included.

Treatment consisting of equal parts of turpentine and olive oil has been found to be 69 percent efficient in removing tapeworms. The birds should be shut up at night and the following morning given one-half to one tablespoonful of the mixture. Food in the form of a mash may be given the birds within three hours after treatment and to this should be added one-half pound of Epsom salt for 100 adult birds. Regular feeding can then be continued, but the flock should be kept housed until the following morning. The houses should then be cleaned thoroughly, as described under roundworms.

A convenient way of giving birds individual medical treatment is to use a piece of  $\frac{3}{8}$ -inch glass tubing that has been drawn out on either end in the form of a pipette. By being careful this can be inserted directly into the crop. A piece of glass tubing 15 inches long and  $\frac{3}{8}$  inch in diameter will hold about three teaspoonfuls, and by carefully sucking it full, three birds may be treated by one filling. The quantity can be guided by placing the forefinger over the free end of the tube and letting the liquid pass gradually down the esophagus and into the crop. Care must be taken not to get any of the liquid into the trachea (windpipe) and to have the end of the tubing well rounded off with a file so as not to injure the mouth or esophagus while inserting it.

Arecoline hydrobromide, given in 0.1 grain doses, has given good

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61. Wolfenbarger, D. O., and Hoffman, E. Uses of DDT on the poultry farm. *Poultry Sci.* Vol. 23. pp. 545-547. 1945.

results. The method used is to dissolve 0.1 grain of the drug in 4 ml. (one teaspoonful) of water and administer to each bird as described under the turpentine treatment. The dose should be repeated in ten days or two weeks. Great care should be taken in administering this drug since it is very toxic and enough research work has not been done with it to determine the lethal dose for fowls.

Copper sulphate in a 1 to 2,000 solution (1 level teaspoonful to each 5 gallons of water) has been found fairly effective for tapeworms. This should be used for two weeks instead of drinking water. A 1 to 400 solution, as recommended in the past, is injurious and the birds will not drink it.

Chandler<sup>62</sup> has recommended the use of iodine preparations for the control of intestinal worms in poultry. He states that a small amount of iodine applied in the proper form will destroy both the worm eggs and worms.

A product called iodine suspensoid has been developed which is claimed to destroy worms and eggs on floors and in soil. For cleaning floors the treatment is at the rate of one gallon per 100 square feet, and for soil three gallons per 100 square feet. The product has a commercial strength of about 4 percent iodine and is diluted twenty times with water at the time of using.

There has also been developed an iodine vermicide which is recommended for treating the birds. The dosage of this product ranges from one-half ounce, in case of young birds weighing from one to three pounds, to one ounce for adult birds. It is administered directly into the gizzard by means of a flexible catheter.

This treatment should be repeated after 10 days. It is also of value in treating turkeys, although a special catheter is necessary for these birds. The iodine compounds do not appear to injure the birds or to cause them to go out of production as much as most other drugs. Its chief disadvantage is that it requires special equipment and individual handling. However, it is probably the most effective method of removing worms. It is especially important since the iodine destroys the worm eggs.

If tapeworms are present it is recommended that each bird in the breeding flock be given a treatment early in the winter to remove as many of the worms as possible. Such birds will not then become heavily infested until the intermediate hosts (flies, etc.) are again present the following spring. This will allow the birds to pass the winter in much better physical condition and thus avoid many cases of colds, roup, etc., to which infested birds are susceptible.

All the precautions in regard to sanitation should be observed when this treatment is used. Success will depend on the thoroughness of the application, and a badly infested bird that does not get any of the treatment may be a source of reinfestation of the entire flock. This makes individual treatment preferable.

62. Chandler, W. L. Iodine on the poultry farm. *Poultry Sci.* Vol. VI, No. 1, pp. 21-35. Oct.-Nov., 1926.

**Skin Flukes.**<sup>63</sup>—Chickens and turkeys as well as common wild birds, such as the sparrow, are sometimes infested by flukes of the genus *Collyriclum*. The life history of the fluke is very complex. Evidence has been accumulated to show that a certain species of snail acts as the first, and dragon-fly larvae as the second intermediate host. Birds which frequent lake borders and swampy land suffer most.

#### Symptoms

The most conspicuous lesions are small blisters about the vent and along the lower parts of the body. These blisters sometimes develop as a berrylike mass. The cysts are smooth and shiny, grayish-white in color and vary in size from 2 to 3 mm. in diameter. Frequently a mass of degenerating cysts may be removed, leaving an irregular yellowish-white area.

#### Control

Adequate control measures cannot be devised until we have a better knowledge of the life history of the parasite. At present the only suggestion to be offered is to keep chicks and poults on dry, well-drained, and sanitary runs.

### MISCELLANEOUS DISEASES

Many cases of disease are due to a variety of causes so that it is not possible to classify them except in a miscellaneous group. Here also are placed certain diseases of unknown cause.

**Pullet Disease.**—This disease has been given a variety of names "blue comb," "summer disease," "X-disease," "new wheat poisoning," etc. This was probably described first by Beaudette in 1929 as "X-disease." It was described in adult birds in heavy production with symptoms somewhat like those of fowl cholera, but without any infectious agent which could be demonstrated. The condition was characterized by cyanosis of the comb and wattles and sudden death.

The disease is fairly widespread in the northeastern part of the United States and has been found in Kansas. All types of chickens are susceptible although it predominates in heavy breeds. It is most prevalent in birds of 5 to 7 months of age but is occasionally observed in chicks and old birds. It has been reported in turkeys. The peak of the infection is in August. The cause of the disease is not known. Various suggestions have been made as to the cause but no infectious agent has been incriminated. Some investigators consider the presence of excessive amounts of common salt in the feed may be responsible, and salt poisoning leads to similar symptoms. The feeding of new wheat is believed to predispose the birds to this condition. The recommendation is not to feed new wheat until it has passed through a sweat in storage.

63. Riley, W. A., and Kernkamp, H. C. H. Flukes of the genus *Collyriclum* as parasites of turkeys and chickens. Jour. Amer. Vet. Med. Assoc. Vol. 17, n. s., pp. 591-599. 1924.

### Symptoms

The appetite is lost, and the bird becomes listless and depressed. There may be diarrhea, the crop is frequently distended with sour-smelling liquid, the comb darkened, eyes sunken, skin of legs shriveled, sometimes high fever. Mortality ranges from 0 to 50 percent of the flock.

In the more chronic outbreaks the birds may exhibit nervous symptoms and impaired vision. Individual cases are usually overlooked and many birds recover in a week or two. Egg production drops for some time and the birds may go into a partial molt.

The post-mortem findings are not highly diagnostic. The liver is spotted and there is usually congestion of the intestine. The kidneys may be swollen and contain excessive urates (visceral gout). The spleen is unchanged. There are frequently small punctiform hemorrhages of the membranes of the peritoneum, gizzard and pericardium. When birds are in heavy production the ovary may contain soft, irregular and broken egg follicles.

### Control

No specific treatment has been developed for pullet disease. Certain writers believe that it may be an infectious disease, others consider it more in the nature of a toxemia due to faulty nutrition. There is a possibility that it may be both. The feeding of new wheat is to be avoided.

When this condition develops in a flock it is necessary to reduce the feed considerably, clean and scald the drinking vessels each day and change the water three times daily. Epsom salt should not be given. The addition of 10 percent by weight of molasses or brown sugar in the drinking water is of value. The use of 1:2000 copper sulphate or 1:4000 potassium dichromate in the drinking water has been recommended. However, these chemicals should not be added with the molasses or sugar.

The following is the recommendation of Roy E. Jones, Extension Poultryman, Connecticut University: Use 25 lbs. blackstrap or feeding molasses, 50 lbs. bran and 50 lbs. ground oats. Growing mash or laying mash may be used in place of the bran and ground oats if necessary. For small flock treatment, use 1 qt. of molasses to 10 lbs. of mash. Feed what wet mash the birds will clean up in two to three hours, preferably in the morning, every day for a week.

Experiments conducted by Jungherr and Scott, University of Connecticut, indicate that potassium chloride is the active ingredient in molasses which helps in bluecomb treatment.

Use 1 level tablespoonful per gallon of drinking water for one week. Muriate of potash fertilizer is an economical source of potassium chloride. Use a grade containing 60 percent or more  $K_2O$ , which is equivalent to 95-percent potassium chloride. A refined grade of muriate of potash containing 62-percent  $K_2O$ , used for industrial purposes, is available in 100-lb. moisture-proof bags from

wholesale drug companies. This source of potassium chloride must be kept in a tight container, else it will absorb moisture and cake.

The key to successful treatment is having material on hand ready for immediate use when symptoms are noticed. Every poultryman with a flock of 300 or more growing or mature stock should have either 5 gallons of molasses or 10 lbs. of potassium chloride on hand.

**Poisoning.**—Birds may be injured by consuming poisons from four different sources: (a) Those of microbial origin, such as poisoning by *Cl. botulinum*; (b) those from insects, such as rose chafer,<sup>64</sup> bees, etc.; (c) organic poisons of plant origin, such as death camas, ergot, and nicotine; (d) inorganic poisons, arsenic, lead, common salt, etc.

Poisoning may result from eating decomposing organic matter in which the botulinus organisms have been growing as described earlier in this bulletin. Some cases of poisoning may result from birds eating considerable numbers of rose chafers.

Bee stings are highly injurious to birds, especially to ducklings.

Heavy infestations with tapeworms and other parasites appear to result in symptoms of poisoning and intoxication although no definite toxic compounds can be isolated from them.

There are numerous organic poisons of plant origin which may cause losses in flocks not receiving an adequate amount of green feed. Such losses may be overcome by correct management. One type of such poisoning is described below.

**Poisoning by Death Camas.**—While this condition is rarely diagnosed it may be more common than is generally supposed: An outbreak of poisoning by this plant caused a short investigation to be made of the effect of the plant on adult birds.

The disease occurs in the early spring when there is little green feed or after a late frost when the other green plants have been killed. The plant somewhat resembles an onion but is without odor. It is widely distributed in Nebraska, Kansas, Oklahoma and Texas.

### Symptoms

A few hours after eating the tops of the plant the birds show signs of poisoning. There is weakness and excessive flow of saliva. Poisoned birds may remain in this condition for several days before death. There is a profuse putrid diarrhea and no appetite. There is staggering gait and difficulty in walking. On post-mortem examination there is observed inflammation of the intestines and congestion of the lungs. If the birds live several days ulcerated patches appear on the comb.

64. Lamson, G. H., Jr. The poisonous effects of the rose chafer upon chickens. *Science*, n. s., 43:138-139. 1916.

Gallagher, B. A. Rose-chafer poisoning in chickens. *Jour. Amer. Vet. Med. Assoc.* 54:692-695. 1920.

### Control

There is no satisfactory treatment for poultry poisoned by death camas. The best method of control is to keep the birds off the open range, where the plant is commonly found. Plants should be removed from all yards. When there is plenty of green feed birds will not eat the death camas.

**Milkweed Poisoning.**— There is some evidence that birds may be severely injured by eating the green leaves of the milkweed early in the spring. The birds show a sloughing of the lining of the crop and inflammation of the anterior portion of the intestine. Birds on adequate green pastures do not eat these weeds.

**Chemical Poisoning.**— Probably the most common form of poisoning in fowls is that due to common salt. Brines, salty dish water, or foods thrown away because they contain an excessive amount of salt, will often be the source of salt poisoning. Various sprays (Paris green, Bordeaux mixture, etc.), rat poisons, etc., are other examples of poisonous materials often accessible to fowls. The use of metal drinking fountains for containers of medicated drinking water may be a source of danger, since many drugs have a chemical action on metals which results in the formation of poisonous compounds. Sour milk or buttermilk may have the same action if left for any length of time in tin or galvanized vessels.

Since the use of poison mash for the destruction of grasshoppers is a common practice in this part of the country, the question is frequently asked about the poisoning of domesticated birds by this procedure. Numerous careful inquiries have been made regarding this point and at present it is generally agreed that birds are rarely if ever injured from eating poisoned insects.

The use of mercury ointment for the control of lice during the incubation period will poison and seriously injure the embryos within the eggs.

### Symptoms

The sudden appearance of a large number of sick birds showing darkened combs, prostration, and wryneck, should lead one to think of poisoning. On post-mortem examination erosions, a parboiled appearance of the inner surface of the crop, and a severe catarrhal or hemorrhagic enteritis are usually present. These findings, however, are not diagnostic since many diseases show similar lesions. In case poisoning results from rose chafers, these insects may be found in the intestinal tract. This is also true of poisonous plants, and if death is caused by sprays some of the material may be found on the premises.

### Control

Treatment is seldom of value. Milk, lard, and other demulcent liquids are indicated, followed by a tablespoonful of castor oil. The birds should be enclosed in small pens until the source of the trouble is located and removed.

**Heat Stroke and Sunburn.** — Overheating will often cause birds to fall over or walk with a staggering gait. Birds suffering from indigestion or other disturbances are more prone to the condition than are healthy individuals. Recovery generally occurs if the affected bird is removed to cool, comfortable quarters.

Young birds of certain slow-feathering breeds or birds suffering from tapeworm infestation, so that they develop feathers slowly, may become badly sunburned. Such birds must be given adequate shade. Adequate shade is very necessary for all young game birds.

**Sod Disease.**<sup>65</sup>—Sod disease, vesicular dermatitis, is commonly found in young chicks that have free range on heavy sod lands. It is characterized by a severe swelling of the feet, resembling bumblefoot to a certain extent, but usually spreading over the entire foot. In many cases the skin of the head about the eyes and beak is affected in much the same way. It is thought to be caused by irritation of the part by the stiff sod, which paves the way for secondary infection by pus-producing organisms. There may be some question of vitamin deficiency, although this point has not been adequately investigated.

#### Control

Remove the chicks from the sod runs until a few weeks old and treat each bird by removing any exudate present and applying tincture of iodine to the wound. Keeping chicks off heavy sod pastures until they are a few weeks old will do much in the way of prevention. Increase the amount of young green feed, alfalfa or dried milk.

**Lameness (Rheumatism).** — Lameness (not due to paralysis) is a condition which is often associated with such diseases as tuberculosis and tapeworm infestation and may be considered a symptom and not a disease in itself. Poor housing and inadequate diet or mash containing an improper mineral mixture<sup>66</sup> may cause lameness and swollen joints, and if a large number of birds become so affected, the ration and housing should receive immediate attention in order to stop the condition as soon as possible. Lameness resulting from infections or worms is corrected by the elimination of the primary disturbance. Birds sometimes suffer from an infection of the joints or nerve sheaths and show symptoms similar to rheumatism in higher animals. Occasional infection of the joints by *Pasteurella avicida* (the organism causing cholera), *Streptococci*, or *Salmonella, aertrycke* will result in rheumatism. Birds suffering from rheumatism show signs of severe pain when handled. Proper housing conditions will do much to control this disease. Birds should not be subjected to sudden changes in temperature as will exist in drafty or poorly ventilated houses.

**Bumblefoot.** — This is a suppurative disease of the foot of all domestic fowls, but found most often in the heavier breeds. It is

65. Newson, I. E., and Feldman, W. H. Sod disease of chickens. Colo. Agri. Expt. Sta. Bul. 262:1-12. Fig. 5. 1920.

66. See perosis, page 84.

characterized by a slow swelling of the foot that finally results in the formation of an abscess or a hard, tumorlike growth.

The common causes of the condition are jumping from high perches to hard concrete floors, roosting on too narrow perches, continuous walking on bare concrete floors, and any injury that will bruise or injure the bottom of the foot. Certain writers believe that lack of vitamins, particularly A, will predispose to this condition. After the tissues have been injured the staphylococci and other bacteria may become established in the area and cause a chronic abscess which does not heal.

#### Symptoms

The condition is seldom seen in more than one or two birds at a time. The first sign of the disease is a severe lameness. When the fowl is picked up, a hot, painful swelling is noticed on the ball of the foot and between the toes. Usually this is an abscess with a corelike center, although at times only a hard, tumorlike growth is to be seen.

#### Control

Treatment usually involves surgery, and if the bird is worth the expense of an operation it should be taken to a veterinarian to be treated. Often, after the foot is lanced, it requires some time to heal the wound, and therefore the market is the best place to take an injured bird unless it is valuable as a breeder.

Prevention consists in seeing that the roosts are not too high from the floor that the perches are not too narrow; that plenty of litter is kept on the floor; and that injuries from splinters, sharp stones, etc., are promptly cared for. Properly balanced feeds will also be of value in preventing its development.

**Tumors.**—Tumors in fowls are not uncommon, but usually do not cause much economic loss, since old birds are more liable to be affected. However, losses may be severe in young flocks affected with leucosis (a tumorlike condition).

Most tumors are observed as local enlargements, usually firmer and lighter in color than the surrounding tissues. However, they vary greatly in structure according to the type of tissue of which they are composed.

Various types of tumorlike conditions have already been discussed, the leucosis (leukemia), and neurolymphomatosis. (See page 41.) The former involves the blood-forming organs and the latter the nerves, although both may be due to the same cause. The cause of tumors is not known, but many appear to be due to the action of a filter-passing virus. In some instances there appears to be an inherited tendency to this condition, in others an infectious agent may be an important factor. The exact reasons for their development are not known.

Treatment of external tumors is surgical, while treatment of internal ones is generally impossible, since they are not discovered until the death of the bird.

**Crop Bound (Impaction of the Crop).**—Continued feeding of dry grains and fibrous material, paralysis by irritating drugs, or the presence of foreign bodies often cause fowls to become crop bound. The first symptom noticed is an enlargement of the crop, which upon examination, will be found to be filled with a hard mass of food. If the condition is not relieved, pressure on the trachea (windpipe) may cut off the air supply and cause suffocation. After passing water into the impacted crop, massage toward the head. This will often relieve the condition by forcing the food out of the mouth. If this does not suffice, the crop should be opened by making an incision in the upper part of the organ. The contents may then be removed, and the wound sutured with ordinary linen thread which has been dipped in tincture of iodine. The walls of the crop should be sutured separately from the skin, and extreme care taken to use disinfected instruments in performing this operation. If a veterinarian is available and the bird is a valuable one it will pay to take it to him for treatment. Follow the operation with soft feeds until the bird recovers.

**Pendulous Crop.**—An enlarged and pendulous crop is fairly common in chickens and quite prevalent among turkeys. Although the crop becomes greatly distended and pendulous it does not appear to greatly inconvenience the bird as long as it is empty. When the bird takes considerable food and water it becomes a great inconvenience and may be bruised or torn by the feet of the bird itself. Some recent work by Hinshaw, in California, indicates that there may be certain hereditary factors operating in this condition.

The contents of the crop may be removed by suspending the bird head down and allowing the fluid to drain out of the mouth. A section of the skin over the crop may be tied off to give temporary relief until the bird can be marketed. A strong thread or fine wire may be used for the purpose. This section of the skin will soon become necrotic and slough off.

There is little to be done for the bird. As in the case of crop-bound, the surgical removal of a considerable portion of the crop wall may be of value. The same aseptic precautions should be observed as described above. After the operation the bird must be given a small amount of soft feed at frequent intervals until it has recovered.

**Egg Bound.**—This condition is often seen in pullets, but also is found in old hens due to attempts at passing malformed and double-yolked eggs. In young birds inflammation of the oviduct or production of too large eggs tends to cause the retention of eggs in the oviduct.

#### Symptoms

Listlessness, frequent attempts to lay, and often a prolapse of the cloaca and oviduct characterize the disease. In extreme cases the bird may assume a penguin-like posture. Symptoms described un-

der prolapse of the oviduct follow the eversion of the organ. Often the cannibalistic habits of the other birds described under vent, gleet develop, and in such cases the affected bird may die from injuries.

#### Control

Ward and Gallagher<sup>67</sup> prescribe the following procedure to remove a retained egg: Have an assistant hold the bird with her back down while operator passes his forefinger through the vent and into the oviduct until the egg is felt. With the fingers of his other hand, pressing on the external wall of the abdomen the egg is forced outward, being guided by the inserted forefinger. When the shell is visible it should be punctured with a sharp-pointed knife and broken into pieces with a pair of forceps or the hands, and the pieces removed. The patient should be isolated and injections of cold water forced into the inflamed areas two or three times daily. Greasing or oiling the parts previous to treatment will aid in the removing of the egg.

*Ulcerative Cloacitis (Inflammation of Cloaca).*—This disease, commonly called “vent gleet,” is thought to be an infectious venereal disease of fowls, but no definite causative organism has been found. It is thought that it is spread by coition, and is characterized by a congestion of the membrane of the posterior part of the cloaca and interior portion of the vent. The inflammation may extend into the oviduct and rectum.

#### Symptoms

Severe irritation, frequent voiding of small stools, a watery discharge that soon becomes foul-smelling, and a swollen and reddened area around the vent are diagnostic symptoms. The fowl will pick at the irritated surface, and other birds attracted by the discharge and the reddened area will injure the swollen part and cause ulceration. Death often results from the wounds thus caused. Egg production in a flock suffering from vent gleet falls off materially, and fertility is lowered.

#### Control

Isolate the affected birds, clean the external parts affected, clip the feathers around the vent, and break away all scabs. Then smear zinc oxide or mercurial ointment on both the external and internal surfaces. The cloaca can easily be reached by passing the finger through the vent. Male birds should be isolated as soon as vent gleet appears in the flock to prevent spreading of the disease by coition. Thorough disinfection of the premises should be practiced.

In some cases a diet too high in protein, such as tankage or meat scraps, may cause this trouble. In such cases it will be necessary to change the feeding practice to correct it.

<sup>67</sup>. Ward, R. A., and Gallagher, B. A. Diseases of domesticated birds. 333 pp. Fig. 69. The Macmillan Co. New York. 1922. (Ref. p. 165.)

Some practical poultrymen consider that heavy infestation of lice may predispose the membranes of the vent to infection. This is a factor which may be easily removed.

***Prolapse of Oviduct.*** — Following “egg bound” conditions the oviduct often becomes highly congested and along with the cloaca is everted through the vent (blow-out). Often, if the affected fowl is not rescued as soon as the abnormality results, other birds will pick at the prolapsed portion and even pull it away and devour it (pick out).

#### **Control**

Isolate the bird, smear the oviduct with zinc oxide or mercurial ointment and explore it to determine the cause. If a retained egg is present it should be removed. The prolapsed organ should then be returned carefully through the vent, and when in place cold water should be injected to relieve the congestion and cause the walls to contract. Treatment may have to be repeated several times before the bird is cured.

As the occurrence of one case of prolapsed oviduct, particularly in closely housed flocks, may result in vent picking of healthy as well as the affected birds, serious harm with heavy losses may result in a short time.

Birds that are particularly active and those that are the chief offenders may be controlled by removing the tip of the upper beak. A shallow cut is made on each side of the beak about one-eighth inch back of the point, the tip is then broken off at this point. It is not desirable that the point be entirely cut off as the “quick” is much more readily injured when a knife is used to complete the procedure. This simple operation will not prevent the bird from eating normally, nor will it decrease production or otherwise injure the bird. It takes about three weeks for the point of the beak to grow back to normal. After this length of time the bird seldom takes up the habit again.

Since much of this condition in pullets is due to excessive forcing for early and heavy egg production its control depends largely on correcting this factor. Pullets are not mature enough to withstand such treatment and the owner must decide on whether he wishes to obtain eggs or keep his pullets in a healthy condition. It will not be possible to have both. In many commercial flocks it is a common practice to attach a guard to the beak. Such guards are available from most firms supplying poultry equipment.

***Rupture of Oviduct.*** — The oviduct may rupture due to severe inflammation or attempt to pass large eggs or masses of egg material. This allows the egg material to collect in the peritoneal cavity, where it causes peritonitis and occasionally coagulates into solid masses. These masses may become large enough to interfere with the function of the abdominal organs and cause a pendulous abdomen. This condition is not common and may cause some loss where heavy birds are forced to fly from high perches to a hard floor.

### Symptoms

The bird ceases to lay, the abdomen becomes hard and sometimes pendulous and the bird will sit in an upright position. When forced to walk about, the tail may drag on the ground. Sometimes the birds die quickly, the comb showing bluish discoloration. This condition resembles cholera.

### Control

There is no treatment possible except to protect the birds from injury and feed and exercise them to avoid excessive development of fat.

**Ruptured Ova.**— This is an important disease in Kansas. As a cause of death it is more important than botulism. Within the past twenty years birds suffering from this disease have been received at this laboratory from more than 500 flocks. The ova may rupture into the abdominal cavity or they may rupture within the oviduct. In some cases death follows rapidly while in others it does not appear to injure the bird to a great extent.

### Symptoms

When in the peritoneal cavity the yolk may be broken and distributed over the organs and walls. Here it usually becomes thickened and somewhat dry. In turkeys there is a tendency for considerable amounts of fluid to collect. The presence of this material leads to severe catarrhal peritonitis with thickening of the membranes. The birds often die with symptoms of cholera and sometimes the cholera and pullorum organisms may be isolated from the internal organs. Hoffman found that 48 percent of the birds examined exhibited this infection.<sup>68</sup>

### Control

Reduce the amount of protein and concentrates in the feed. Lower the high perches and nests to within 30 inches of the floor and cover concrete floors with a thick layer of straw. Give the birds plenty of exercise and adjust the ration to avoid excessive fat.

**Edema of the Wattles.**— This disease is especially common in a breeding flock containing several male birds. Birds of both sexes are affected, but it is primarily a disease of males. The cause of this trouble is unknown, but in some of the most severe outbreaks the organism of chicken cholera seems to be the primary factor. Several pus-forming organisms have been isolated and the disease probably is not specific.

### Symptoms

The wattles become swollen and hot. In most of the cases but one wattle is involved. The birds become listless and show loss of appetite. The swelling extends to and may involve the head. The wattle

<sup>68</sup>. Hoffman, H. A. Studies on the etiology of "ruptured yolk." Poultry Science 12-189. 1938.

is red at first, but later becomes more yellow and grayish in color. In some cases the liquid within the wattle becomes caseated (cheese-like) and may be easily removed. The diseased wattle shrivels and in some cases becomes one-half the size of the unaffected wattle. The death rate is not high, but the birds lose flesh and become unthrifty and may be killed by the more vigorous birds.

#### Control

This infection usually gains entrance to the wattle through wounds due to fighting. Davis<sup>69</sup> has recommended the practice of cropping the wattles and thus removing them from possibility of mechanical injury and freezing. Heavy clamps are placed on the wattles close to the lower mandible to reduce hemorrhage. The wattles are cut off by means of curved shears and the cut edges treated with chloride of iron solution or an astringent dusting powder. When the clamps are removed there is very little hemorrhage and infection is rare.

The process of removing the comb and wattles from young birds is becoming a common practice. This is of considerable value in cold parts of the country where subzero weather is common in winter. The removal of the comb is referred to as "dubbing"; the removal of the wattles as "cropping." Birds of three or four months of age may be dubbed with tinner's shears, which crush the tissues and produce less bleeding than a sharp instrument. Hemorrhage may be controlled by applying a strong clamp and treating the severed area with a 5 percent ferric chloride solution. If this is not available, a clean feather placed on the cut surface, or the application of a small amount of flour or finely ground feed will hasten coagulation of the blood.

This operation is sometimes performed on chicks. A fine pair of scissors is most satisfactory for the purpose. There is no pain and little bleeding.

**Frozen Comb and Wattles.** — When these appendages of the head become frozen, they should be thawed out by smearing with vaseline and rubbing with the fingers. If the injury is too bad, removal of the wattles and comb may be necessary.

**Wounds and Fractures.** — Wounds result from ravages by dogs, by beasts of prey, by fighting, and by intentional abuse by the owner or assistants. Treatment consists in clipping the feathers from the injured area, washing with a 2 percent solution of compound cresol and applying a dusting powder. Hemorrhages can usually be stopped by packing the wound with pledgets of cotton, since a fowl's blood clots very quickly. Wind puffs resulting from caponizing can be corrected to some extent by making an x-shaped cut in the skin to allow the air to escape. It may be necessary to repeat this two or three times.

69. Davis, D. E. Edema of the wattles in cockerels. Jour. Amer. Vet. Med. Assoc., Vol. 19 (a. s.), No. 5, pp. 588-598. Feb., 1925.

Unless the bird is a valuable one a broken bone should not be treated, but the bird butchered. Fractures heal readily and if a leg bone of a valuable bird is broken it will pay to set it. Splints should be made to fit the leg, and these should be left in place for a week.

## VICIOUS HABITS

**Toe Pecking.**—Toe pecking is most commonly seen in brooder chicks and is a habit acquired by the chicks pecking at the feet of their mates, often resulting in blood being drawn. Once the chicks get the taste of blood the habit is strengthened and the weaklings of the flock usually suffer most. Often many of the chicks will suffer the same abuse and large losses may result.

The correction of this habit is brought about by isolation of the offenders and the removal of injured birds until they are cured. Food hung above the chicks' heads gives them something to divert their attention, and will help to keep them from pecking at objects on the ground. Ruby colored lights and red paint on the windows have been recommended to mask the red color of blood.

**Cannibalism.**—This habit is usually the result of improper methods of management, inadequate and monotonous diets, overcrowding, too great fluctuations in temperatures, or conditions which tend to cause the birds to be uncomfortable. After the habit is once acquired it is difficult to control. In adult birds the control is the same as described under the heading "Prolapse of Oviduct." In chicks the condition may be relieved by correcting the feeding methods and placing the birds under brooding conditions which are less congested. Free range with plenty of finely chopped green feed supplied daily will help keep it under control.

Reports have recently come from several experiment stations that cannibalism is most severe in flocks receiving a mash containing large amounts of corn. This deficiency was controlled by reducing the corn and replacing it with ground oats. There is considerable evidence to indicate that the difference in manganese may be responsible for this, since oats contains 4.66 mg. and corn 0.38 mg. of manganese per 100 grams. The addition of 2 percent common salt to the mash for two or three days has been found to be of value in controlling cannibalism. One tablespoonful to each gallon of water for a half-day is a satisfactory method of supplying salt. Continuous feeding of salt does not give good results. Injured birds should be removed from the flock as quickly as discovered. In some instances the tip of the beak of the cannibal may be carefully removed. This does not interfere with taking food but prevents injury to other birds.

A recent report from the Wisconsin experiment station<sup>70</sup> states that the feeding of fresh cow manure may prevent cannibalism. This should be fed once each day. Use moderate amounts at first

70. Annual Report, Director Agricultural Experiment Station, University of Wisconsin. Bulletin 463. Part 2, p. 33. 1944.

since, if birds are fed too much they will not eat enough mash to maintain egg production. This should be fed in troughs arranged to prevent the birds from walking in them. Usually about 150 hens will consume the manure from one cow. There is no danger in this practice since no diseases are transmitted from the cow to the chicken. The effectiveness of this treatment is believed to be due to some nutritive factor which the birds crave. This may be some of the B vitamins which are found in large amounts in cow manure.

**Egg Eating.**—Egg eating is a habit that is started by birds getting a taste of eggs that have been broken. The offenders can usually be picked out by their yolk-stained beaks, and should be killed or at least isolated from the flock.

Oyster shells should be kept before the birds continually so that they will not have a chance to develop a craving for lime. Darkened nests that have plenty of straw in them aid in controlling this habit, both by making broken eggs hard to be seen and decreasing the chance of breaking the eggs.

**Feather Pulling.**—Birds do not object to having their feathers pulled and even seem to like the sensation. Consequently a bird that gets such a habit is not induced to stop by the actions of the offended, and once an offender gets the taste of blood that is on a pulled feather the habit becomes a vicious one. Overcrowding or nervousness lead the bird to become a feather puller, Itching following molting, and monotonous diets are other factors leading to the feather-pulling habit.

If the cause of feather pulling is a result of an infestation or a faulty diet, these factors should be corrected. If it is simply a habit with a few individual birds, the offenders should be removed. Plenty of exercise and green feed may help to correct the habit. Increasing the amount of oats in the mash is said to correct this habit. Bits made of wire and placed in the mouth will stop feather pulling without interfering with eating when birds are hopper fed.

### SOME THINGS WHICH KILL YOUNG BIRDS

1. **Filthy Runs.**—Runs that are muddy and foul will weaken chicks. Such runs are also likely to harbor eggs of worms and other internal parasites and disease-producing bacteria. All runs should be well drained, cleaned frequently, limed, and seeded thickly to oats. Chicks should be kept away from stagnant ponds, pigpens, and old manure heaps.

2. **Lice and Mites.**—These vermin should be removed as previously described.

3. **Lack of Ventilation.**—Impure and moist air is very dangerous to chicks. Runs, brooders, and houses should be well ventilated and exposed to the sunshine.

4. **Drafts.**—Proper ventilation without drafts is absolutely essential to the successful rearing of young chicks.

5. **Dampness.**—There are several sources of dampness in runs and brooders. The dampness may be due to improper construction and drainage of the floors, moisture from the breath and excrement of the chicks, leaking and upset drinking fountains, etc.

6. **Lack of Sunlight.**—Sunlight has been found to be of great value as a disinfectant. It is also of value in preventing the development of leg weakness in chicks. However, chicks should not be exposed to the direct rays of the summer sun, but should be furnished shade to seek as they desire. Two percent potent cod-liver oil added to the feed may be used as a substitute for sunshine.

7. **Overcrowding.**—Chicks grow very rapidly and thus must be given floor space according to size and age. Overcrowding makes chicks unthrifty and some of the weaker ones obtain very little to eat in crowded runs. Close contact also makes the spreading of disease, lice, and worms an easy matter, and leads to cannibalism.

8. **Variation in Temperature.**—Chicks require a steady, even heat in the brooder; but they also require a cooler place to which they can move if they desire.

9. **Lack of Pure Water.**—The body of the chick is 55 percent water, this being lost constantly through the droppings and through the respiratory tract. For this reason birds require large amounts of drinking water. They will not drink the necessary amount, however, if it is filthy. Water should be offered in such a manner that the chicks cannot get into the fountain with their feet and thus contaminate it with intestinal contents. The drinking water should be changed three times each day. Drinking utensils should be scalded each time the water is changed. Use care to place the utensils within reach of the chicks.

10. **Spoiled Feed.**—No moldy or tainted feed of any kind should be fed to chickens. This is especially true of moldy sour milk or buttermilk. Many cases of brooder pneumonia, limberneck, and bowel trouble are traced to spoiled feeds.

11. **Improper and Inadequate Feeding.**—In addition to the troubles due to feeding spoiled feeds there may arise diseases due to lack of certain essential elements. The feed not only must be balanced, as to the proper amounts of protein, carbohydrates, fats, and ash, but must also contain certain vitamins. The most important of these for young chicks are vitamins A and D.

Young chicks should be fed sparingly but often throughout the day, and enough to fill the crop before roosting time. However, it should be kept in mind that the chick grows very rapidly and the amount of feed given should be increased from day to day. Too heavy feeding of cracked corn or corn meal will cause bowel trouble. Wilted or spoiled green feed should never be given, although fresh green feed is very essential. Sour milk contains lactic acid, that seems to control intestinal fermentation, and it is especially valuable as a feed for young chicks.

12. **Suffocation.**—Chicks raised in brooder houses that are cold and damp crowd together and have a general tendency to pile up, each one trying to get to the center of the pile. It is usually the strongest chicks that succeed in getting to the center and then the owner wonders why the most vigorous chicks suffocate. It is simply because they are the strongest and can fight their way to the warmest place and then have not the strength to get out. Sometimes a similar condition results when only a small spot of the brooder house is flooded with sunlight. The chicks all try to crowd into this small area, which will often result in one or two chicks becoming smothered. It has been recommended that a light be kept in the brooder house all night to prevent crowding. There have been reports of chickens being poisoned with gas from improperly regulated coal and oil stoves. In case of heavy losses this point should be investigated.

Evenly heated brooder houses and the training of chicks to go to the hover when cold, will do much to correct losses from suffocation,

13. **Diarrhea Other than that Due to Pullorum Disease.**—Young chicks often suffer from diarrheas that are not of an infectious nature. Among the causes of such diarrheas are: (1) Overheated or underheated brooder houses, (2) very fine sand (sand scours), (3) sudden chilling, and (4) improper diet. Correction of the condition causing the diarrhea will usually prevent a spread of the disease.

14. **Coccidiosis.**—This disease does not usually cause loss until the chicks are three or four weeks of age, but chicks less than one week of age have been known to be affected.

15. **Too Rapid Chilling of Freshly Hatched Chicks.**—Under no consideration should chicks be moved to lower temperatures while still wet. They should be held at a relatively high humidity to prevent too rapid drying and consequent chilling in forced-air incubators.

16. **Pullorum Disease.**—This disease and its control have been discussed earlier in this bulletin.

17. **Paratyphoid** infection frequently causes losses among poults. This disease is commonly confused with pullorum disease.

## APPENDIX

**Disinfection of Drinking Water.**—Clean, fresh, cold water is more necessary for poultry than most owners realize. However, it is commonly neglected and frequently is an important source of disease germs.

Disinfection (destruction of disease germs) of water is a very common practice among poultrymen. This is necessary only when the birds become sick. Most poultrymen consider that this operation will control all their difficulties. As a matter of fact it is of very limited value. Very few disinfectants will destroy coccidia or worm eggs, when used in concentration which the birds can drink. The practice has value only against disease-producing bacteria. However, it should be understood that the process is not always complete for these organisms.

Waters vary in their chemical composition. Clear water is more easily disinfected than cloudy or muddy water, and some constituents of water will combine with the disinfectant before the bacteria are all destroyed. Some disinfectants destroy metal containers by combining chemically with the metal. Such compounds should not be used in galvanized iron utensils.

Potassium permanganate is a common disinfectant for poultry drinking water. When it turns brown, it has lost its disinfecting properties. Add one level teaspoon to each gallon of water and keep before the birds as long as losses persist.

Chlorinated lime, or bleaching powder, contains about 30 to 35 percent of available chlorine and is a very effective germicidal agent when fresh. It is unstable and of no value in wooden vessels or in water containing mud and filth. For clear water it may be used as follows: Prepare a stock solution by adding one pound of bleaching powder to one quart of water. Keep this in a well-stoppered bottle. Add one teaspoonful of this stock solution to each two gallons of drinking water. Allow to stand 30 minutes.

Tincture of iodine is very effective, but expensive. Eleven drops in an ordinary pailful of water is most commonly recommended.

Birds do not usually like to drink water containing disinfectants and if used in too heavy concentrations, they refuse to drink and may be injured because of a lack of water. Use of disinfectants in the water cannot be considered a substitute for sanitation. The most satisfactory germicidal agent is water boiling hot. This is especially true when wooden utensils are used. All utensils should be cleaned daily and the water changed three times each day, unless running water can be installed.

**Disinfectant Whitewash.**—The following formula is one that is recommended for preparing a whitewash that has a disinfectant value in addition to its other properties:

- (1) Hydrated lime .....1½ pecks.
- (2) Salt .....2 pounds.
- (3) Commercial lime-sulphur dip .....4 gallons.
- (4) Water .....40 gallons.

Equivalent amounts for a small quantity of the above whitewash are approximately as follows:

- (1) Hydrated lime .....1 heaping quart.
- (2) Salt .....3 tablespoonfuls.
- (3) Commercial lime-sulphur .....1½ quarts.
- (4) Water .....4 gallons.

Alum added to a lime whitewash lends adhesiveness. An ounce to the gallon is sufficient. A pound of cheap bar soap dissolved in a gallon of boiling water, then added to about five gallons of boiling water, and it in turn added to about five gallons of thick whitewash, will give it a gloss like oil paint. Two applications should be made each year, one each in the fall and spring. To insure penetration in cracks and crevices, the operation is preferably done with a high-pressure spray pump.

**Kerosene Emulsion.**—Shave one-half pound of hard laundry soap into one-half gallon of soft water and boil the mixture until all the soap is dissolved. Remove it to a safe distance from the fire and stir into it, while still hot, two gallons of kerosene. This makes a thick, creamy emulsion which may be used as a stock solution. When used for killing mites it should be mixed as follows: To one quart of this emulsion add nine quarts of water.

The emulsion can readily be converted into a disinfectant by stirring well and adding one pint of crude cresol or crude carbolic acid to the total amount of stock mixture. This should then be stirred until it is well mixed.

**Medicated Vaseline.**—Vaseline, 2 ounces; crude carbolic acid, 1 teaspoonful. Mix well before applying and use for wounds, etc.

Another type of medicated vaseline is prepared according to the directions of Beach and Halpin,<sup>71</sup> using formaldehyde. The vaseline is placed in a closed jar and melted in a water bath. To this is added 5 percent by weight of commercial formalin. Replace the lid at once and shake until the vaseline hardens.

**Lime-sulphur Mixture.**—A lime-sulphur dip suitable for treating against tropical mites may be prepared as follows:

- 1. Unslaked lime .....1/3 pound
- 2. Sulphur .....1 pound
- 3. Water .....4 gallons

Boil for 2 hours.

(The slaking of the lime serves to dissolve the sulphur.)

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<sup>71</sup> Beach, B. A., and Halpin, J. G. Observations on an outbreak of favus. Jour. Agr. Res. 15:415. 1918.

**Fumigation of Incubators.** — Studies made at the Kansas Agricultural Experiment Station indicate that the following method of fumigation is satisfactory.

Formaldehyde gas is generated by mixing commercial formalin (40 percent formaldehyde in water) and potassium permanganate.<sup>72</sup> These compounds are mixed in an enamelware vessel and placed about three feet from the floor in the middle compartment of the incubator, or in a special device on the outside. In the latter case the gas is conducted into the compartment by means of an especially designed flue. Equipment for generating and introducing the gas into certain forced-air-draft incubators may be obtained from the manufacturer.

Thirty-five ml. of commercial formalin and 17.5 grams of potassium permanganate crystals are recommended for each 100 cubic feet of incubator space. Most of the gas is liberated within a few minutes, but the doors of the incubator should not be opened for ten minutes. It is unnecessary to close the ports during the fumigation. Still-air-incubators may be fumigated by opening them and treating the entire room in which they are housed.

The Illinois experiment station has developed a simple and effective method of releasing the formaldehyde from cheese cloth.<sup>73</sup> The formalin was absorbed by a square of cheese cloth (approximately one yard) and hung on a glass rod near the fans. The air currents produced by the fans and the heat of the incubator caused the formaldehyde to evaporate within a few minutes. The use of 20 ml. ( $\frac{2}{3}$  oz.) of formalin per 100 cubic feet proved practical in destroying *S. pullorum* in the incubator within a short time.

No doubt any method which will free the formaldehyde gas will be satisfactory, but this compound is very irritating to the membranes of the nose and throat and considerable care should be used to select a method which will protect the operator from its action at all times. This necessitates an effective method of ventilation to remove the fumes from the building as quickly as possible.

It should be kept in mind, however, that dry formaldehyde gas is of little value as a germicidal agent and that a high humidity greatly increases its efficiency.

72. To prevent the mixture from foaming over, the container used should be large enough to hold five to six times the amount of mixture employed. If the vessel is placed inside the incubator it should be placed above a larger vessel to prevent the hot mixture from reaching the floor in case it does boil over.

73. Graham, R., and Michael, V. M. Studies on incubator hygiene. Poultry Science 11, pp. 197-207. 1932.

DOSAGE TABLE FOR ADULT FOWLS

DRUG.	Therapeutic Dose.	Nontoxic Dose.	Toxic Dose.
Ammonium carbonate.....	10 to 15 gr.....	20 gr.....	
Areca nut (powdered).....	3 to 4 gr.....	5 to 10 gr.....	
Arecoline hydrobromide.....	0.1 gr.....		
Calomel.....	5.0 gr.....	30 gr.....	
Capsicum.....	1 to 4 gr.....	5 gr.....	
Carbolic acid.....	0.5 gr.....	2 gr. in sol.....	5 gr. in sol.
Calcium phosphate, ppt.....	15 gr.....	30 gr.....	1.25 dr.
Castor oil.....	1 dr.....	6½ dr.....	
Charcoal.....	5 gr.....	10 gr.....	
Chenopodium (oil of).....	5 minims.....		
Cod liver oil.....	1 percent of ration.....	5 percent of ration.....	
Cottonseed oil.....	1 dr.....	143 cc. of 1 to 500 sol.....	
Catechu (powdered).....	2 to 5 gr.....		
Catechu (tincture of).....	2 to 5 minims.....		
Copper sulfate.....	1 to 2 gr.....	3 to 10 gr.....	15 gr.
Copperas.....	10 to 20 gr.....	30 gr.....	
Digitalis (fluid extract).....	10 to 20 minims.....	20 minims.....	
Epsom salt.....	1 dram.....		
Gentian.....	10 gr.....	2 dr.....	1 ounce
Ginger.....	15 gr.....	5 dr.....	
Ipecac (powdered).....	0.5 dr.....	0.75 dr.....	1 dr.
Ipecac (fluid extract).....	0.5 dr.....	0.75 dr.....	1 dr.
Linseed oil (raw).....	1 dr.....		
Mustard.....	5 to 7 gr.....	10 gr.....	
Nux vomica (powdered).....	10 to 15 gr.....	2 dr.....	1 ounce
Potassium permanganate.....	2 to 6 gr.....	15 gr.....	30 gr.
Quinine sulfate.....	2 to 3 gr.....		
Salicylic acid.....	1 to 5 gr.....	5 to 15 gr.....	30 gr.
Santonin.....	0.5 to 2 gr.....	5 to 15 gr.....	
Sodium chloride (common salt).....	5 gr.....	1¼ to 1½ dr.....	2½ dr.
Strychnine sulfate.....	0.25 to 0.5 gr.....	2 gr.....	3 gr.
Sulphocarbonate of calcium.....	¼ to ½ gr.....		
Sulphocarbonate of sodium.....	¼ to ½ gr.....		
Sulphocarbonate of zinc.....	¼ to ½ gr.....		
Turpentine.....	0.5 dr.....	2½ dr.....	
Thymol.....	1 gr.....	3 gr.....	

NOTE.—The figures in this tabulation are for the average adult fowl, and should be varied according to age and size.

NORMAL TEMPERATURES OF POULTRY

Hen.....	104.0 to 107.6° F.
Turkey.....	104.0 to 106.7° F.
Duck.....	105.8 to 109.4° F.
Goose.....	104.0 to 105.8° F.

*Information on the Agglutination Test for Pullorum Disease.*—The flock should be tested just before the breeding season as there is little if any reduction of the egg production due to bleeding. Below are given directions for bleeding chickens for the agglutination test. It is essential that every precaution be followed very carefully. Unless blood reaches the laboratory in a good condition it will be impossible to use it for making the test.

## EQUIPMENT FOR COLLECTING BLOOD

The following special articles of equipment are necessary for drawing blood for the standard tube test. This is the only method suitable for turkey testing.

1. Small sharp-pointed scalpel or knife, or a 2 ml. Luer-Lok syringe and hypodermic needle. For chickens a 20- or 22-gauge and for turkeys an 18- to 20-gauge needle may be used.
2. Leg bands for each fowl to be tested.
3. One dram homeopathic, or shell vials or small tubes for collecting samples.
4. Corks to fit, and labels for marking.
5. Clean towel or piece of cloth for cleaning instruments, before proceeding with the next bird.
6. Some six-ounce bottles of physiological salt solution with 10 percent glycerine are necessary for rinsing the syringes between bleedings.

### PROCEDURE

1. Catch each bird and mark with a leg band bearing a number.
2. Hold the fowl in a convenient position to permit spreading of one wing and exposure of the wing veins.
3. Pull a few feathers in the region of the first wing joint to expose the skin over the vein. (It is not necessary to disinfect the area.)
4. Puncture the vein with a quick movement of some sharp instrument. The cut should be lengthwise and not across the vein if made with a scalpel. Scissors may be used instead of a scalpel. If scissors are used a small cut is made in the exposed surface of the vein. This cut is made across the vein and not lengthwise. A more recent method of collecting blood is to use a 2 ml. Luer-Lok syringe.
5. Immediately collect the blood in the vial. Fill at least one-half full. Cork tightly and label with the leg-band number. An indelible pencil is more efficient for this than a fountain pen, since ink may blur. Be sure to write figures plainly and correctly.
6. Place the vial at an angle and allow the blood to clot. Keep as nearly body temperature as possible during this period.
7. Press the vein tightly with the fingers or pull a few of the downy feathers and pack them over the wound if bleeding does not stop immediately.
8. Store the vials in a cool place such as a refrigerator, but do not allow the blood to freeze.

### PRECAUTIONS

1. Use clean, dry, sterile vials for collecting blood. (Sterilize by placing both corks and vials in a dry hot oven for ten minutes.)
  2. If the blood is to be shipped during hot weather it is necessary to dry two drops of 5 percent solution of boracic acid on the sides and bottom of each vial as a preservative. Request special handling by the express company.
  3. Have the skin dry at the time of taking the blood.
  4. Thoroughly wipe the instrument or rinse the syringe as each sample is taken.
  5. Do not place blood samples in the sun. They must be kept cool to prevent spoilage.
  6. Do not allow blood to freeze. It is better not to bleed in freezing weather. Frozen blood hemolyzes and cannot be used for the test.
  7. Do not allow water to come in contact with the blood. It has the same effect as freezing.
  8. Avoid the use of disinfectants other than boracic acid for the preservation of the blood.
  9. Collect plenty of blood.
  10. Ship samples immediately after collection.
- The following directions are given for making the whole-blood test in the field.

## EQUIPMENT FOR MAKING THE TEST

(The stained-antigen, rapid, whole-blood test)

1. Small sharp-pointed knife or scissors.
2. Clean towels.
3. A glass plate or a white opaque surface ruled in inch squares may be used.<sup>74</sup>
4. Several wire loops with a handle 3 inches long for transferring drops of blood to plate. It is convenient to have the blood-letting knife and loop on opposite ends of the same handle.<sup>75</sup>
5. Stained antigen (test fluid). This may be obtained only from certain dealers who are authorized to prepare and sell it under government supervision.

### PROCEDURE

1. Transfer a small drop of the stained antigen to each square on the ruled plate.<sup>76</sup>
2. Hold bird in such a position that a tip may be cut from comb or a puncture made into a wing vein. (Each bird is then placed in a separate holder of some sort.)
3. Transfer a loopful of blood to one of the squares on the plate.
4. Mix blood and antigen at once by stirring with loop. Spread over an area about one inch in diameter.
5. Allow to incubate for a short period. (The length of time of incubation will depend on the temperature.) If 60° to 80° is used two minutes should be sufficient. The plate should be moved or tilted occasionally to thoroughly mix the blood and antigen. (The mixture should not be stirred continually.)
6. After incubation the test should be read. A clumping of the stained material indicates a positive reaction, and the bird should be placed in a crate to be disposed of at once. The nonreacting birds may be allowed to go free.

If there are a few doubtful or borderline reactions it is best to dispose of the birds unless they are especially valuable. In this case they may be placed in quarantine and tested a few weeks later.

There are certain precautions to be observed in making the field test. If the bleeding and testing are done inside the poultry house, it becomes necessary to take precautions against dust. If birds are

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74. Some type of heating device must be used to warm the tests during cold weather. Probably the simplest is to use a tin can with flat sides which may be filled with warm water. (Too much heat is to be avoided.) Complete electrically heated equipment may be obtained from many poultry supply houses. Such complete outfits should be purchased if much testing is to be done.

75. A 24-gauge nicrome wire bent into a loop  $\frac{3}{16}$  inches in diameter has been recommended as most satisfactory. This will transfer approximately 0.02 ml. of blood.

76. Care must be observed to measure this drop carefully. The antigen droppers supplied by various sources vary to some extent in the size of drop released. Directions for the use of antigen should be obtained whenever it is purchased. The pipette should be held perpendicular to the plate and high enough so that the tip does not touch the plate. It is impossible to measure antigen accurately if it flows from the pipette onto the plate.

handled carefully the amount of dust is greatly reduced. Also many testing boxes are provided with a clear glass top so that the tests are protected during the incubation period, and can be read without exposing them to the air.

The loop and knife should be rinsed by dipping in water and then dried on a clean towel between each test. If a syringe is used it should be rinsed twice with clean water and then with the saline mixture. If only water is used some blood cells are destroyed and blood-stained serum results. This interferes seriously with the tube test.

The test should be read in a good light. Daylight is most satisfactory. When this is not available, an electric light suspended directly above the testing apparatus will give good illumination. If an electric light is not available a battery flashlight may be used.