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KANSAS STATE COLLEGE OF AGRICULTURE
AND APPLIED SCIENCE

MANHATTAN, KANSAS

POULTRY DISEASES, THEIR PREVEN- TION AND CONTROL

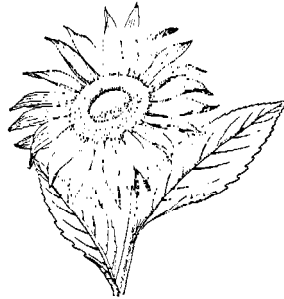


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POULTRY DISEASES—THEIR PREVENTION AND CONTROL¹

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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 fifth in number of fowls raised, and ninth in poultry products sold. In 1935, \$13,188,000 worth of poultry and eggs were sold in Kansas. This is nearly one-third of the total amount realized from the sale of all other food animals. 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.

Acknowledgment.—This bulletin is a revision of Bulletin 247 of the Agricultural Experiment Station. The authors take pleasure in acknowledging the assistance of Drs. J. G. Jackley, F. R. Beaudette, W. R. Hinshaw, and C. A. Brandy in collecting some of the information. Special credit is due Dr. W. R. Hinshaw for his exhaustive studies on pullorum disease, and Dr. C. A. Brandy for his excellent work on certain of the virus diseases. Much valuable information has been furnished by Prof. L. F. Payne and Prof. H. M. Scott, of the Department of Poultry Husbandry of this college.

1. Contribution No. 169 from the Department of Bacteriology

ESSENTIALS OF POULTRY HYGIENE

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

Sanitation.— 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.

To determine more accurately the effect of sanitation, test pens of chickens were maintained under farm conditions at the Kansas Agricultural Experiment Station. One was given a minimum of care, which meant, very little more than feed and water. Another was given a maximum of care, which meant sufficient to maintain thoroughly clean and sanitary quarters. Table I shows the result. It will be noted that a death loss of 42 percent in the insanitary pen apparently could have been reduced to 7 percent by simple clean-up methods.

TABLE I.—EFFECTS OF SANITATION ON DEATH RATE

	Losses per hundred birds.												Total.
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
Minimum care...	1	3	6	10	8	5	3	2	1	1	1	1	42
Maximum care...	0	0	0	1	2	2	1	1	0	0	0	0	7

The same results are shown diagrammatically by figure 1.

Sanitation can be maintained only by having a regular schedule for cleaning and disinfecting. No matter how small the flock the weekly cleaning should not be omitted.

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 micro-organisms. Most people would consider the intestinal excreta, the manure, as so much lifeless and inert refuse, but the bacteriologist knows that this is not true. 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 of the microscope. 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,

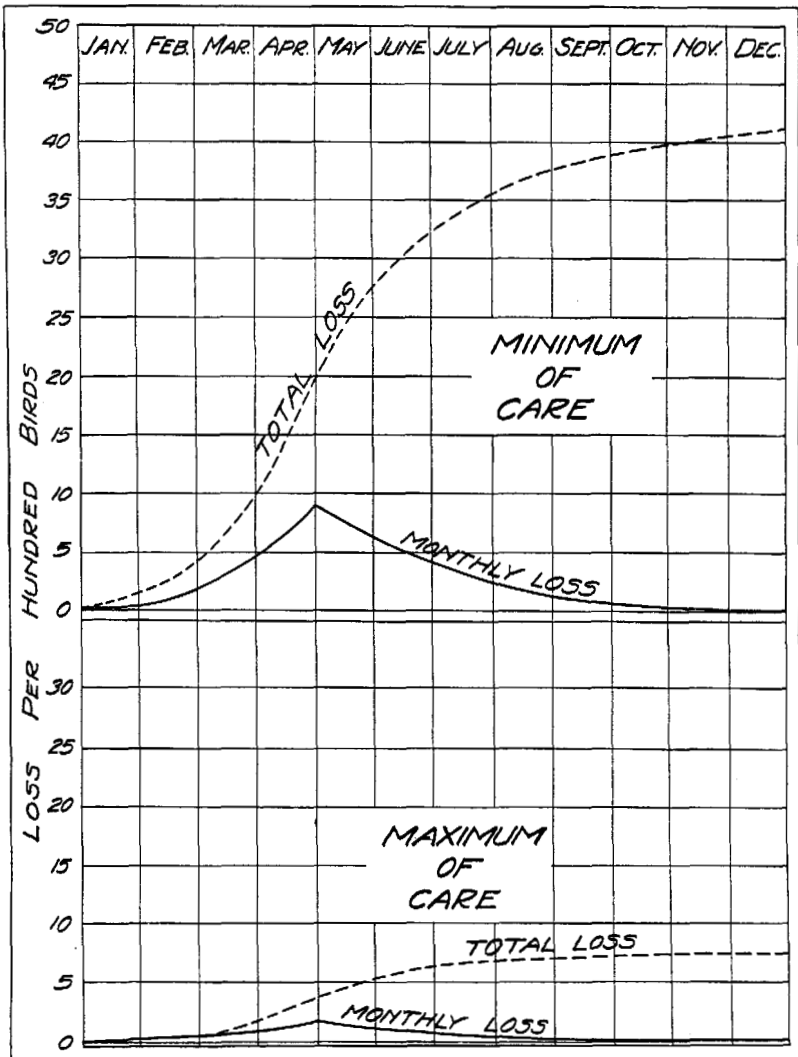


FIG. 1.—Graphs showing the effect of sanitation on disease control.

mites, and others—is also important.² 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.

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.— 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

2. Bishopp, F. C., and Wood, H. P. Mites and lice on poultry. U. S. Dept. of Agr. Farmers' Bul. 801:1-19. Figs. 1-15. 1931.

3. Dorset, M. Some common disinfectants. U. S. Dept. of Agri. Farmers' Bul. 926:1-10.

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 "chloride of 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 effectiveness of this solution will depend entirely on the available chlorine content of the original chloride of lime. Many of the samples of bleaching powder on the market are of little or no value. The purchaser should insist on a fresh shipment.⁴

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 compound cresol. This is sprayed over the walls and floors. After drying it is followed by a spray of whitewash.⁵

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.⁶

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 118.

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.

Isolation and Quarantine.—On the average farm, isolation of sick 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. It does not mean putting up a wire fence between them. 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 unaffected 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 will be the direct cause of another outbreak.

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. Many outbreaks of disease are started by introducing new stock from other flocks. 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. This also holds true for day-old chicks purchased on the market. Sparrows 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.

CARING FOR THE FLOCK⁷

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 herewith.

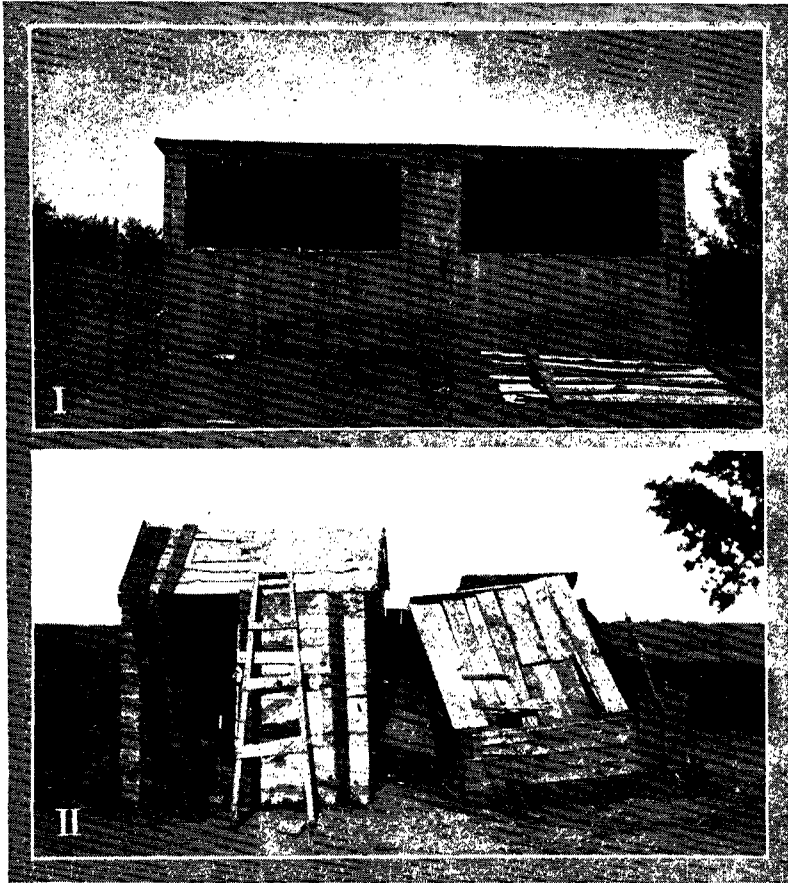


FIG. 2.—Equipment in use on some farms. With such equipment it is not surprising that results are unsatisfactory and that interest in poultry is at a low ebb.

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.

First of all, the house⁸ 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



FIG. 3.—A back-yard flock which averaged 101 eggs each in 8 months as two-year-old hens. The income for eggs from 58 hens was \$182.50 and the cost of feed was \$55.10. Note construction of house.

be kept dry. Plenty of room should be provided in order to avoid crowding of 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 reach the interior. Sunlight serves another purpose in being 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.

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

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 is 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 three 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 recently come into wide use. They 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 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.

Most diseases are spread through contaminated water, feed and air. Keeping the 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 keep healthy longer than the one that is thin, scrawny, undersized, and weak in the legs. Excessive fat indicates lack of exercise or lowered vigor in a hen 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 the 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 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, 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 six different vitamins required by poultry are recognized; namely, A, B, C, D, E, and G. A lack of one or more of these vitamins in the feed may lead to certain characteristic symptoms in the affected bird.

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.

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.

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. Oats 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 satis-

factory 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."

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, 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. Since poultrymen are agreed that, owing to the low unit value of the bird, individual treatment is not desirable except in case of especially valuable birds and simple treatment. From experience at this station it has been found it is about as easy to cure sick birds by proper treatment and nursing as it is to cure any other sick animal 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 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 to 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 18 years of investigation on poultry diseases at this Agricultural Experiment Station. During that time we have studied some 50,000 birds from nearly 20,000 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 II 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 4 were plotted from the figures in Table II.

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.

TABLE II.—DISTRIBUTION BY MONTHS OF 6,069 OUTBREAKS OF POULTRY DISEASES IN KANSAS

DISEASE.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals
Fowl cholera:													
Number.....	78.0	89.0	89.0	29.0	24.0	9.0	23.0	17.0	17.0	45.0	44.0	54.0	518
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	
Fowl typhoid:													
Number.....	11.0	8.0	16.0	13.0	21.0	26.0	29.0	30.0	24.0	22.0	15.0	5.0	220
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	
Botulism:													
Number.....	0.0	0.0	0.0	2.0	5.0	16.0	26.0	21.0	18.0	10.0	4.0	0.0	102
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	
Blackhead:													
Number.....	2.0	1.0	2.0	4.0	8.0	14.0	13.0	2.0	8.0	21.0	8.0	3.0	86
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	
A-Avitaminosis:													
Number.....	10.0	22.0	48.0	48.0	32.0	21.0	20.0	19.0	9.0	5.0	6.0	4.0	244
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	
Tuberculosis:													
Number.....	20.0	24.0	31.0	32.0	33.0	21.0	14.0	16.0	16.0	16.0	19.0	19.0	261
Percent.....	7.6	9.1	11.8	12.2	12.6	8.0	5.8	6.1	6.1	6.1	7.3	7.3	
Worm infestation:													
Number.....	184.0	135.0	137.0	127.0	186.0	245.0	322.0	362.0	390.0	357.0	256.0	231.0	2,932
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	
Pullorum disease:													
Number.....	10.0	60.0	273.0	314.0	285.0	66.0	24.0	9.0	5.0	10.0	7.0	5.0	1,068
Percent.....	1.9	6.6	25.0	28.0	26.0	6.1	2.2	1.8	0.5	1.0	0.7	0.5	
Coccidiosis:													
Number.....	20.0	15.0	34.0	72.0	161.0	139.0	77.0	38.0	30.0	23.0	14.0	15.0	638
Percent.....	3.1	2.1	5.3	11.3	25.2	21.8	12.1	5.9	4.7	3.6	2.2	2.3	

POULTRY DISEASES

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:⁹ (1) history of the outbreak; (2) age of the birds affected; (3) a full description of the symptoms; (4) number in the flock; (5) the feed; (6) the treatment

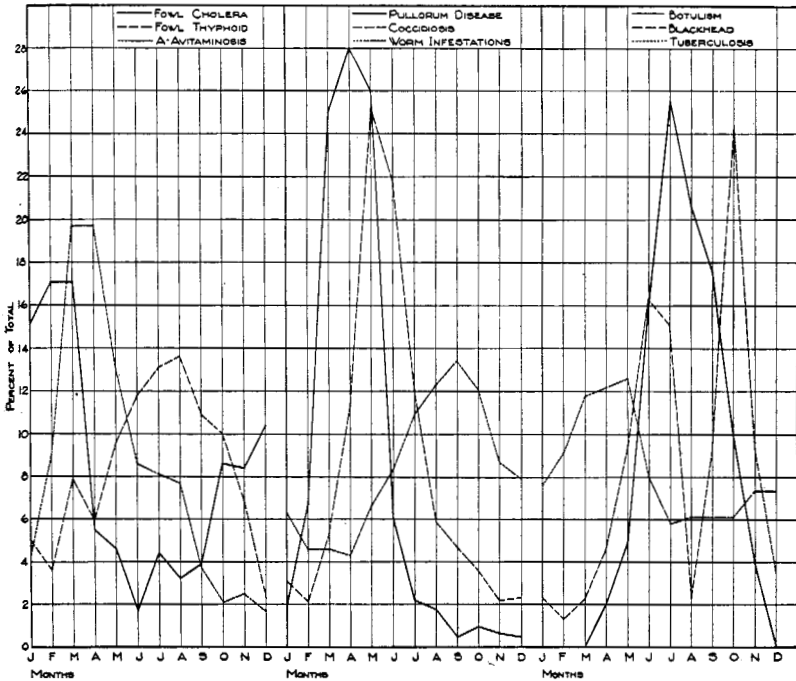


FIG. 4.—Graphs showing the seasonal distribution of some of the more common poultry diseases in Kansas.

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:

10. This is of special importance.

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 10 to the drinking water (1 level teaspoonful for each 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.

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. It is better to starve the birds for 12 to 18 hours before giving salts. 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.

10. See appendix, page 117, for instruction regarding the preparation of drinking water.

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 Fowl pox (internal) Trichomoniasis (Turkey)
COMB	Anaemic (pale)..... { Tuberculosis Air sac mites Intestinal parasites (worms) Fowl typhoid A-avitaminosis Lice and mites Coccidiosis Leucosis (pale or yellow) Fowl pox
	Tumors { Fowl pox Nonspecific

AID IN DIAGNOSIS OF POULTRY DISEASES—CONTINUED

EYES AND NOSTRILS ..	{	Exudate in	{	Colds Ophthalmia (ocular roup) Coccidiosis A-avitaminosis Sod disease
		Blindness		Neurolymphomatosis
MOUTH AND THROAT.....	{	Ulcers in	{	Injuries Avian diphtheria (roup) Trichomoniasis
FEATHERS	{	Unthrifty appearance.....	{	Worms Colibacillosis Lice A-avitaminosis Scurvy Laryngotracheitis Coccidiosis
		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
PARALYSIS				B-avitaminosis Coccidiosis Tapeworms D-avitaminosis Tumors Range paralysis Unbalanced ration Botulism Perosis
LEGS AND FEET	{	Rickets	{	D-avitaminosis
		Dry and rough.....		Scaly leg
		Blisters		Sod disease
		Foot swollen		Bumblefoot
		Joints swollen		Tuberculosis <i>P. avicida</i> infection Gout Rheumatism Rickets (weaklegs)
		Slipped tendon		Perosis
NECK.....	{	Limberneck	{	Cholera (late) Botulism
		Wry neck		Lice in ear Poisoning Worms Ocular roup (ophthalmia) Leucosis

POULTRY DISEASES

AID IN DIAGNOSIS OF POULTRY DISEASES—CONTINUED

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 Infectious asthæmia Intestinal coccidiosis (chronic) Cholera (chronic) Leucosis												
DIARRHEA	{	<table style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 20%; vertical-align: top;">Green</td> <td style="width: 5%; vertical-align: middle;">{</td> <td style="width: 75%; vertical-align: top;"> Fowl typhoid Leucosis </td> </tr> <tr> <td style="vertical-align: top;">White</td> <td style="vertical-align: middle;">{</td> <td style="vertical-align: top;"> Tuberculosis (late) Worms Pullorum disease Cholera Botulism A-avitaminosis Coccidiosis Colibacillosis Sand scours </td> </tr> <tr> <td style="vertical-align: top;">Yellow</td> <td style="vertical-align: middle;">{</td> <td style="vertical-align: top;"> Cholera Blackhead (sulphur droppings) </td> </tr> <tr> <td style="vertical-align: top;">Bloody</td> <td style="vertical-align: middle;">{</td> <td style="vertical-align: top;"> Coccidiosis Cholera </td> </tr> </tbody> </table>	Green	{	Fowl typhoid Leucosis	White	{	Tuberculosis (late) Worms Pullorum disease Cholera Botulism A-avitaminosis Coccidiosis Colibacillosis Sand scours	Yellow	{	Cholera Blackhead (sulphur droppings)	Bloody	{	Coccidiosis Cholera
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Subnormal	{	Botulism A-avitaminosis												
DIFFICULT RESPIRATION	{	Laryngotracheitis and bronchitis Avian diphtheria Gapes Aspergillosis (rare in chickens) Pneumonia Heat prostration												
<i>Internal Symptoms</i>		<i>Diseases</i>												
ESOPHAGUS (nodules in).....	{	A-avitaminosis Trichomoniasis												
LIVER	{	<table style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 20%; vertical-align: top;">Enlarged</td> <td style="width: 5%; vertical-align: middle;">{</td> <td style="width: 75%; vertical-align: top;"> Fowl typhoid (mahogany colored) Leucosis Blackhead Apoplectiform septicemia Tuberculosis Tumors </td> </tr> <tr> <td style="vertical-align: top;">White spots</td> <td style="vertical-align: middle;">{</td> <td style="vertical-align: top;"> Blackhead Tuberculosis Fowl typhoid (white or gray) Tumors Pullorum disease </td> </tr> <tr> <td style="vertical-align: top;">Yellow (in chicks).....</td> <td style="vertical-align: middle;">{</td> <td style="vertical-align: top;"> Chilling Overheating Sand scours </td> </tr> </tbody> </table>	Enlarged	{	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			
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Yellow (in chicks).....	{	Chilling Overheating Sand scours												

AID IN DIAGNOSIS OF POULTRY DISEASES—CONTINUED

INTESTINAL TRACT	Congestion	{ Colibacillosis Cholera Worms Coccidiosis Poisoning B-avitaminosis Apoplectiform septicemia Fowl typhoid
	Thickened wall or ulcers.....	{ Worms Coccidiosis Tuberculosis Blackhead
	Nodules on	{ 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
LUNGS	Congestion (filled with blood)....	Cholera
	Nodules (in chicks).....	Pullorum
	Dark, gray, firm, pus in.....	{ Pneumonia Aspergillosis
TRACHEA AND BRONCHI	Congestion	Infectious laryngotracheitis
	Blood in	(flu) and infectious
	Pus in	bronchitis
	Worms in	Gapes
CROP	Distended with food.....	Crop bound
	Filled with feathers.....	Depraved appetite
	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

AID IN DIAGNOSIS OF POULTRY DISEASES—CONCLUDED

GIZZARD (lining loose).....	{	Alkali poisoning Worms Lack of vitamins
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 (fig. 5) 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 and at the same time twist the head to one side or back 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 tropical 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. (Fig. 6.) 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. (Fig. 7.) 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



FIG. 5.—A bird being held in position ready to break the neck.

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 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.



FIG. 6.—Stage in the autopsy of a bird showing skin properly pulled back and surface exposed.



FIG. 7.—Stage in the autopsy of a bird showing viscera exposed.

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. Partial 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 (fig. 8) 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 af-



FIG. 8.—A typical case of A-Avitaminosis due to lack of vitamin A in the feed. Note white exudate in eye similar to beginning of ocular roup.

ected and the changes in other organs resembled those found in some acute infectious diseases. In chicks two or three months of age nervous symptoms, incoördination, 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. 9.) 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 diphtheritic 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



FIG. 9.—Characteristic nodular lesions as seen in the lining of the esophagus of a bird having died from A-Avitaminosis.

and on the heart which appears as if sprinkled with a white powder. In young birds the bursa of Fabrecius 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 abundant 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.

B-Avitaminosis (Polyneuritis). — Vitamin B (the antineuritic vitamin), unlike vitamin A, is not stored in the tissues in amounts sufficient to protect against periods of protracted deficiency. However, it is abundantly present in the grains; in fresh leaves of many

plants; in skim milk and other milk products; and in yeasts and other substances making up the poultry ration. Thus vitamin B starvation is not at all common under practical conditions. Symptoms of the deficiency develop in a few days to two weeks in diets lacking vitamin B but prompt recovery of affected individuals on receiving a good source of vitamin B is a characteristic and remarkable feature of the disease.

In birds the disease is characterized by extreme nervous symptoms and inability to coordinate certain muscular movements. Sometimes there is a paralysis of the legs and slight paralysis of the muscles of the neck. The symptoms are not as marked as in case of botulinus poisoning or neurolymphomatosis and develop much more slowly. There are no eye lesions.

The internal organs appear shrunken and darker than normal in color. The muscles also appear to be darkened as if they had been exposed to the air. Symptoms other than those due to emaciation and nervous incoordination do not seem to be marked.

C-Avitaminosis (Scurvy). — A lack of vitamin C in the diet of man and many animals causes the disease scurvy. Vitamin C is found in numerous fruits and in green plants. It is generally believed that vitamin C is synthesized by the bird in quantities sufficient for its own needs. The addition of substances containing vitamin C to the ration of poultry has been observed to be of benefit. However, it is probable that the value of such substances is due to appetite stimulating effects and to other vitamins which they contain.

D-Avitaminosis (Rickets). — Vitamin D deficiency results in the development of rickets, a condition which is quite common in poultry. The requirements for this vitamin are high in poultry of all ages. In growing birds considerable quantities of vitamin D are necessary to allow assimilation of necessary minerals, particularly calcium and phosphorus. Only with the necessary 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, in an inclination to rest on the hocks rather than to stand. This condition may become more pronounced and accompanied in some instances by increased nervous excitability. Eventually the chicks may be unable to stand, 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.¹¹

11. In the diagnosis of D-avitaminosis care must be used to differentiate it from a condition known as slipped tendon (perosis). See page 36.

Sunlight as well as other forms of light which contain ultraviolet rays serve the same practical purpose as vitamin D. These rays act upon a substance in the skin known as ergosterol, changing it to 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 a potent cod-liver oil or some other satisfactory fish-liver oil should be added to the otherwise adequate ration.

Laying and breeding flocks that are closely confined usually require a source of vitamin D, at least during the winter months.

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 will supply this necessary vitamin. (Figs. 10 and 11.)

E-Avitaminosis. — Vitamin E is especially important in improving fertility. Its full significance in the poultry industry has not been determined. However, it appears improbable that birds on a complete ration will lack this vitamin since it is found in wheat germ, leaves and most natural feeds.

G-Avitaminosis. — Vitamin G is probably a complex of several factors, one of which is the flavin factor which prevents nutritional leg weakness. Vitamin G deficiency in the diet of man and various animals causes a pellagra-like disease. It has recently been shown that chickens may be subject to a similar disease which develops at an early age and causes high mortality.

It is important to know that under practical conditions many rations fed to breeding flocks may be inadequate in vitamin G. This deficiency may be indicated by a low hatchability of the eggs. The addition of vitamin G to the ration in the form of dried liver, autoclaved yeast, or dried skim milk has been shown to increase hatchability. Other writers state that vitamin G deficiency leads to loss of appetite, decreased growth, degeneration of the nerves, ulcers of the mouth, roughened skin, and enteritis.

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 cause 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 experiment 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 three such 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.



FIG. 10.—Three cockerels of the same age. The one on the left received adequate diet and sunlight. The others received the same ration but no exposure to the sun.

Gizzard factor.—A condition observed in the gizzard may be due to the lack of some fat-soluble factor (gizzard factor) not identical with any of the known vitamins. The absence of this factor results in the development of small areas of necrosis on the lining of the gizzard, especially at the junction of the gizzard and proventriculus. The condition is prevented by feeding young, fresh or dried green plants such as kale, alfalfa, and wheat bran.

"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.

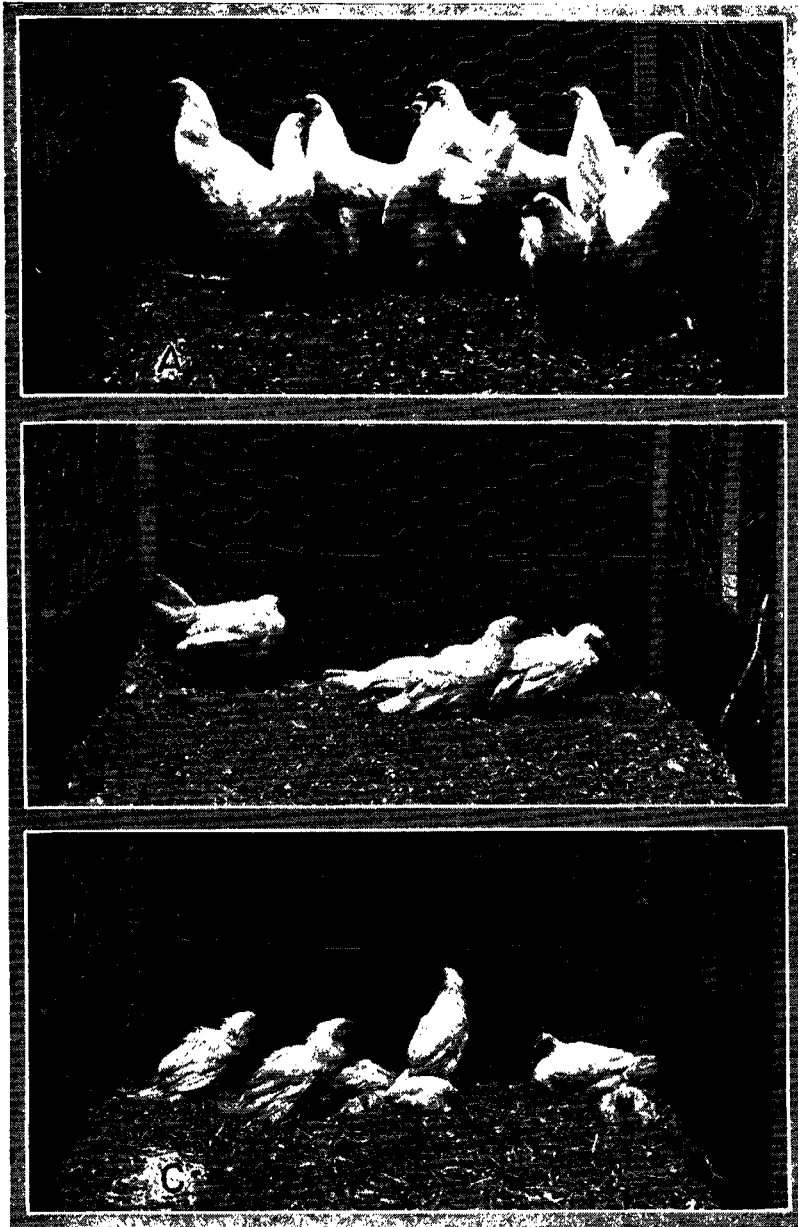


FIG. 11.—Groups of birds of the same age. Group A was given adequate diet and exposed to sunlight six hours per day. Group B was given adequate diet but not exposed to sunlight. Group C. was given adequate diet and exposed to sunlight which had passed through window glass—window glass removes most of the ultraviolet rays.

Slipped tendon (Perosis).—The use of mash with too high mineral content or one containing large amounts of corn for feeding young, rapidly growing birds will frequently lead to an excessive growth of the long bones of the leg. This results in a displacement of the tendon from its condyle on the back of the hock joint, thus the use of the term “slipped tendon.” (Fig. 12.) The use of the term “perosis,” to describe the condition, was unfortunate since the word is derived from the Greek word meaning maimed and is not descriptive of this particular abnormality.



FIG. 12.—Perosis or slipped tendon is due to feeding mash with too much corn and high mineral content. (Note slipped tendon of right leg.)

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 Bearse¹² have reported that the manganese content of grains is as follows in milligrams per 100 grams of grain. Oats 4.66,

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

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.

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 and fowl pox. Leucosis as well as fowl paralysis appear to belong in the virus-disease group.

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,

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.

Symptoms

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. 13.) The nostrils are partly filled with dried mucus. 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 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. Spray-

ing the upper respiratory passage with a hypochlorite solution by means of an atomizer is also beneficial in individual treatment of valuable birds.”¹³

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.



FIG. 13.—Laryngotracheitis—(Gasping symptom).

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.

13. D. Hart. Everyday problems of the poultryman. State Inst. of Applied Agr. Bul. 118 pages. Ill. 34. 1927. (Farmingdale, Long Island, N. Y.) Ref. Section Diseases and parasites.

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 or expose it to direct sunlight. Such exposure 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 by an assistant. 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.

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 parts 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.

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.¹⁴

Symptoms

They may appear within a day or two after hatching. The symptoms are gasping and suffocation. 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

14. 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.

chicks emit a hoarse chirp during the gasping period. 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

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

Fowl Plague.—This disease is frequently called “fowl pest” 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 have 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.

On post-mortem the lungs are found to be congested, 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.

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. 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 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 general 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 typical disease by means of a virus.

Although the symptoms for each disease condition are very different, most recent investigations tend to group those diseases which were formerly called leukemia (leukosis) and neurolmyphomatosis (range paralysis) under the term leucosis. This is because the cause of all these conditions is thought to be the same, although the symptoms are different.

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. 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.

Symptoms

The leucotic symptoms common to the various forms of the disease 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. It is not possible to judge the incubation period in spontaneous field cases but in experimentally inoculated birds it varies from a few days to several months.

The symptoms of neurolymphomatosis 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. 14.) The symptoms are sudden in their onset. The birds appear healthy, then sud-



FIG. 14.—Typical case of neurolymphomatosis involving the left wing. (See Fig. 16.)

denly become lame in one or both legs or lose control of the wings or neck. This is followed by complete loss of use of the legs and the bird becomes rapidly emaciated, following loss of appetite and diarrhea. Sometimes the bird loses control of the neck and paralysis of the eye muscles. 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. Many birds develop a condition of the eye 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.

Post-mortem Findings

From the standpoint of pathology the leucotic type of disease may assume three or perhaps four forms, depending on the tissues involved. In general the liver and spleen become much enlarged—"big-liver disease." (Fig. 15.) The color is usually altered to a pink, yellow, or mahogany. In some instances the surface is uniform

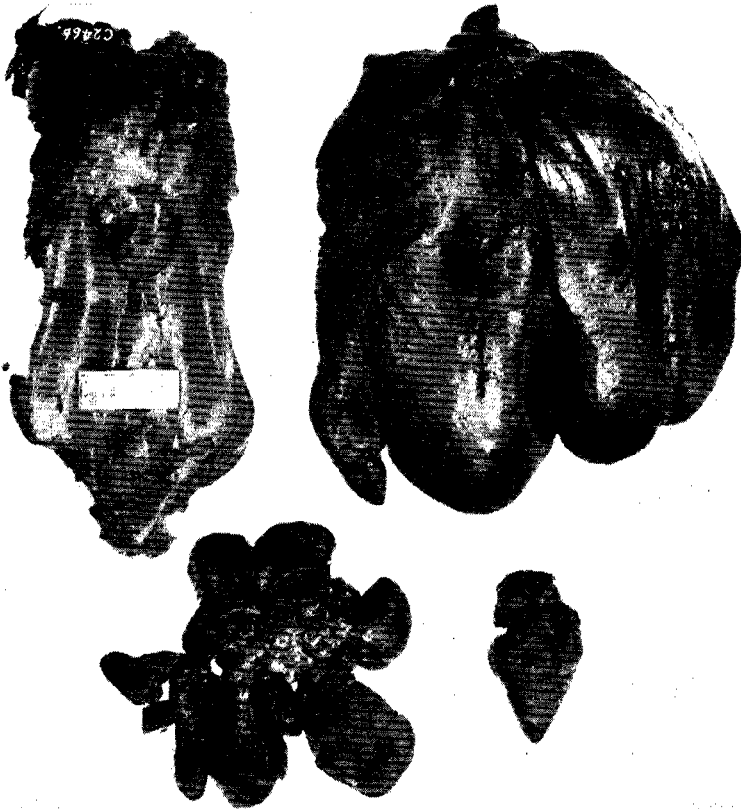


FIG. 15.—Leucosis. This figure illustrates a generalized tumorlike condition involving the breast muscles, liver, ovaries, and heart. Note the enormously enlarged liver.

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.

In the more acute paralytic forms of the disease the general nutrition of the bird is not impaired for some time, although the feathers are frequently matted about the vent and the bird is unthrifty in appearance. Some birds which have been paralyzed show alterations in the peripheral nerves which are usually enlarged and translucent. (Fig. 16.) This condition may be seen in the ganglia and even in parts of the spinal cord.

On microscopic examination the nerves, and some of the involved tissues, are filled with masses of round lymphoid-like cells which give the appearance of a tumor. This has given rise to the name "neurolymphomatosis gallinarum."

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.

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 (page 8) in this bulletin. In certain instances badly diseased flocks have recovered after being placed on screen wire or sanitary runs.

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. 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. 17.)

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 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.

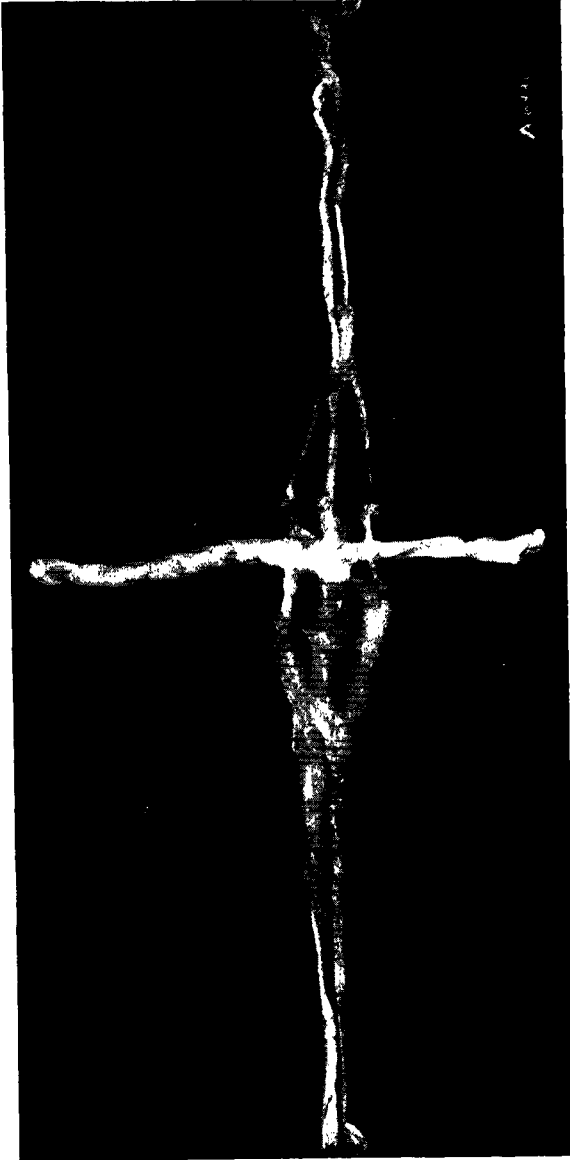


FIG. 16.—Illustrating the involvement of the nerve to the left wing. The nerve to the right wing is normal in size, that to the left wing is greatly enlarged by the infiltration of the tumorlike cells. (Nerve preparation from bird in figure 14.)

Control

Sick birds should be isolated, kept warm, and fed plenty of green feed and sour milk. The tumors may be softened with glycerine or vaseline and removed. The tumors that are removed should be burned. The infected area thus left exposed 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.



FIG. 17.—Head of pullet showing typical fowl pox eruptions (natural infection).

A virus has been prepared that seems to be of considerable value for immunizing birds against this disease. It is best to use virus obtained from a local flock. Persons wishing to try this treatment may write this department⁷ for further particulars.

The vaccine is made by using the dried scabs. It should be used soon 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 must not 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. 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 into this area 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. 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.

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 due to such agents 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. 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 "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.

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 mill 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, 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.

Equally as dangerous as drafts is lack of ventilation. The temperature of the bird is normally high, about 106° F. In order to maintain this temperature the birds must have a plentiful supply of oxygen. 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.¹⁵ 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.

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

Van Es and Olney¹⁶ recommend the alternate use of a 4.0 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.

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. However, if a bird is very valuable it may be returned several weeks after it has recovered. Careful culling several times each day to remove any birds with symptoms 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 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. The cause is not known, but probably many types of bacteria are active as described for fowl coryza.

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 may be 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.

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

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 may be one form of bird 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 *Pasturella 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 with canker. 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 very 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. In chicks of about one month of age the cause may be due to coccidiosis. 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.

Control

Sick birds should be placed in isolation pens, and the eye should be 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 two and one-half



FIG. 18.—Typical cases of ophthalmia (ocular roup). (A) A severe chick case. This is a highly infectious form of the disease. (B) A typical case in an adult hen.

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. 18) are usually of little value and should be destroyed or fattened for the market as soon as possible after recovery.

Fowl Cholera.— Fowl cholera is an acute disease of all domesticated fowls, characterized by its sudden onset and widespread occurrence. 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 roosts in the morning. In the acute type a yellowish 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, ruffling of the feathers, and an increase of mucus in the mouth. Death usually occurs in from 24 to 72 hours.

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 infected with the fowl cholera organism.

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 18, 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.

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.

Apoptiform 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 an 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.

Control

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.

Pullorum Disease. — “Bacillary white diarrhea” 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*,¹⁷ which soon devitalizes the young bird. 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 10 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 the 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 of the egg is unabsorbed.¹⁸ 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.

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

17. The reader should keep in mind that all cases of diarrhea in chicks are not 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 Chicks,” page 114.) Many cases of so-called brooder pneumonia are due to this infection.

18. 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 become 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.

and the content is firm and cheesy. In the male bird the heart and testes are very frequently involved.

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.

It has been found that the disease may be spread from diseased 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.¹⁹

A very important source of the disease in adult birds is contact with infected 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 agglutina-

19. Bushnell, L. D., Hinshaw, W. R., and Payne, L. F. Bacillary White Diarrhea in Fowl. Kan. Agr. Expt. Sta. Tech. Bul. 21:1-85. Figs. 4. 1926.

tion 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.²⁰

There are three agglutination tests commonly used in the diagnosis of pullorum disease. These are referred to as the "standard tube agglutination test;" the "stained antigen, rapid, whole-blood test;" and the "rapid serum test." These have been included as official tests for pullorum disease control under the National Poultry Improvement Plan by the U. S. Bureau of Animal Industry. (See page 120 for details of these tests.)

The success of any of these methods will depend very largely on the experience of the person making the test. While it appears to be an easy matter to prepare and read these tests, there are many sources of error not recognized by those who are not skilled in their use.

The advantage of the rapid, whole-blood test using a stained antigen (test fluid) is that it may be done on the farm and is completed in a few minutes. Leg-banding in this case is not necessary and blood samples need not be sent to a laboratory. However, the test is not quite as accurate as the other tests.

The "pullorin" or "wattle" test has not been perfected to a point where it can be recommended in place of the agglutination test.

Figure 19 shows some of the losses due to bacillary white diarrhea, 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. A bird valued at \$100 will be as great a menace to the flock as one valued at \$1.

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

20. For further information see appendix, page 120, "Information on the Agglutination Test for Pullorum Disease."

Birds suffering from fowl typhoid will give a positive reaction for pullorum disease. This is also true of birds vaccinated for fowl typhoid, 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 dissemination 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

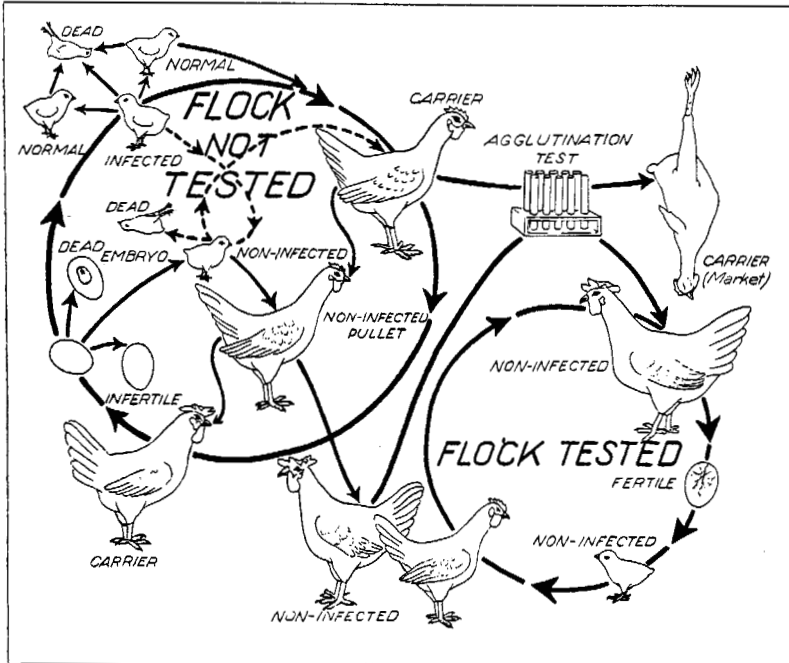


FIG. 19.—Chart showing the possibilities of the agglutination test in controlling pullorum disease in poultry flocks.

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 effectiveness of formaldehyde fumigation. A wet bulb thermometer reading of 85° to 90° F. is desirable at the time of fumigation.²¹

21. 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.

Fumigation between hatches is often desirable, but to obtain the maximum effect from fumigation the procedure may be carried out three times at eight-hour intervals during the time the hatch is coming off. By removing all dry chicks before the second and third fumigations practically all chicks are exposed to one fumigation. 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 plan for the control of pullorum disease. 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:

1. *U. S. Pullorum-Tested Flocks.* Flocks, any members of which are used as breeders, which when tested for pullorum disease under the supervision of an official state agency contain fewer than 10 percent reactors, the last test being made within 12 months immediately preceding the date of sale of hatching eggs or chicks from such flocks. All indicated carriers of pullorum disease shall have been removed from the premises upon completion of the test and disposed of in a manner satisfactory to the official state agency. All birds remaining in the flock shall be properly leg-banded. Individual birds introduced into U. S. pullorum-tested flocks shall have passed within 12 months a negative test for pullorum disease.

A flock containing 10 percent or more reactors on the first test, upon being retested at intervals of not less than 30 days and all reactors removed after each test until the percentage of reactors is less than 10, may qualify as a U. S. pullorum-tested flock.

2. *U. S. Pullorum-Passed Flocks.* Flocks, which when tested for pullorum disease under the supervision of an official state agency, contain no reactors, the last test having been made within the testing year immediately preceding date of sale of hatching eggs or chicks from such flocks. All pullorum tests of flocks of this class, or flocks that are candidates for this class must be reported to the supervising official state agency, and reactors occurring in unofficial tests shall be considered on the same basis as any reactors in official tests.

Birds may not be added to U. S. pullorum-passed flocks except after the approval of the official state inspector, and then only from U. S. pullorum-passed or U. S. pullorum-clean flocks.

3. *U. S. Pullorum-Clean Flocks.* Flocks, any members of which are used as breeders, which when tested for pullorum disease under supervision of an official state agency, contain no reactors in two consecutive tests not less than 6 months apart, the last test being made within the testing year immediately preceding the date of sale of hatching eggs or chicks from such flocks; provided that the first one of these two consecutive tests will have met all of the provisions of a U. S. pullorum-passed flock. Once a flock is established as U. S. pullorum-clean it remains so as long as no reactors are found on the official annual test of birds used as breeders. When one reactor or not more than one-half of 1 percent of a flock and in any case not more than 6 birds in any flock, which in the previous year or years had a U. S. pullorum-clean rating, is found to be positive on any test for pullorum disease, a retest of all birds to be used as breeders may be made at the discretion of the official state agency not earlier than 30 days or later than 6 weeks after the first test. If the retest reveals no reactors the flock may again be declared to be U. S. pullorum-clean. All pullorum tests of flocks of this class, or flocks that are candidates for this class must be reported to the supervising official state agency, and reactors occurring in unofficial tests shall be considered on the same basis as any reactors in official tests.

A flock developed exclusively from purchased hatching eggs produced by a U. S. pullorum-clean flock and hatched in a U. S. pullorum-clean hatchery may be recognized as a U. S. pullorum-clean flock, on one annual test conducted under the supervision of an official state agency if no reactors are found.

Birds may not be added to U. S. pullorum-clean flocks except after the approval of the official state agency and then only from U. S. pullorum-clean flocks. The number of birds and the name and address of the person from whom the purchase is to be made shall be furnished the official state agency when making application for birds to be added to the original flock. In moving birds from one farm to another due precaution should be taken to use clean, sanitary coops.

The official test for pullorum disease in 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,
- (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)] for pullorum disease shall be approved by the U. S. Department of Agriculture.

No other eggs shall be incubated in the same incubator or in the same room as eggs from G. S. pullorum-tested, U. S. pullorum-passed, or U.S. pullorum-clean flocks. Eggs from U. S. pullorum-tested flocks shall not be incubated in the same incubator or in the same room with eggs from U. S. pullorum-passed, or U. S. pullorum-clean flocks. No other chicks shall be hatched in the same incubator or in the same room or brooded in the same room as chicks from U. S. pullorum-tested, U. S. pullorum-passed, or U. S. pullorum-clean flocks. Chicks from U. S. pullorum-tested flocks shall not be hatched in the same incubator or in the same room as chicks from U. S. pullorum-passed or U. S. pullorum-clean flocks.

In separating a room for the use of two or more incubators, in order to comply with this provision, a tight partition is absolutely necessary and must be provided. Outside ventilation and an outside entry for each room is required. Any door or opening between the two rooms must be sealed when chicks are being hatched, packed, or stored in the room where eggs from nonpullorum-tested flock are hatching. All incubators used for hatching U. S. pullorum-tested, U. S. pullorum-passed, or U. S. pullorum-clean chicks must be thoroughly cleaned and disinfected by spraying or fumigation after each hatch, using an officially recognized method.

U. S. pullorum-tested, U. S. pullorum-passed, or U. S. pullorum-clean classes of chicks, flocks, and hatcheries may be attained, produced, advertised, and sold by any hatchery or poultry breeder complying with the requirements outlined in this plan.

Further details of the plan may be obtained by writing the U. S. 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.

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 will have a greenish diarrhea. It is generally believed that a pale comb is characteristic, but the cases that have been examined at this laboratory recently 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 yards with drooping head and wings.

Post-mortem Findings

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.

Colibacillosis of Chicks. — This disease, although not very common, has been found to cause heavy losses in broods of chicks from two to eight weeks of age. 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 an infectious disease known as 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.

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" 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 "food poisoning group." At present the classification of these organisms is not well established, but in general, they are of the *Salmonella aertrycke* type. These organisms have been reported from infections of young chickens, turkeys, ducks, 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.

Emmel²² has reported this organism either of direct or indirect importance in range paralysis. This point requires further study. There is frequently a severe inflammation of the eye, leading to an ophthalmia. In pigeons sometimes there is marked wry-neck. These birds frequently reveal swollen joints and inability to fly to the perches.

Recent reports from the Idaho station 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. The organism responsible for these outbreaks was *S. aertrycke*. About one-third of the breeding hens were found to be reactors and carriers of the infection, by means of the agglutination test, in dilutions of 1:50 or above.

Post-mortem Findings

The spleen, kidneys and liver are usually swollen; the lining of the intestine congested and the lumen filled with a slimy mass or fibrinous exudate. A similar 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

In most 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 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.

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. 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 pos-

22. Emmel, M. W., 1935. The etiology of fowl paralysis, leukemia and allied conditions in animals. Fla. Agr. Expt. Sta. Tech. Bul. X, pp. 24. 1937.

sible that man may occasionally get the disease from birds. Swine may become infected with avian tuberculosis by association with affected birds. 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 have devised a method of classifying the various types of tubercle bacilli as shown in Table III.

TABLE III.—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, pp. 132, 1930).

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. (Fig. 20.) 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.

Post-mortem Findings

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 some 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. 21.) 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.

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 birds over one year of age, 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.²³ 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



FIG. 20.—The breast bone and muscle of a normal bird (left) and of a bird suffering from a well-advanced case of tuberculosis.

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.

23. 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.

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

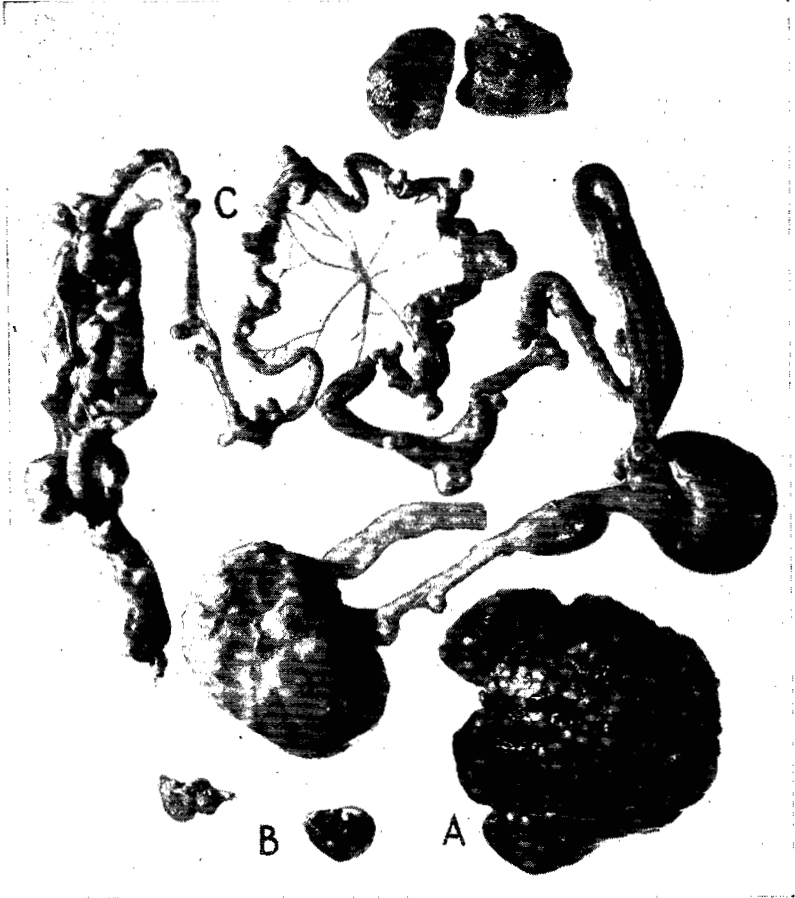


FIG. 21.—Viscera of a tuberculous bird. (A) Liver, (B) spleen, and (C) intestines.

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.

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. (Fig. 22.) Usually a large number of the flock are affected at one time, and are found lying in a prone position.



FIG. 22.—A bird showing characteristic symptoms of botulism (limberneck).

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*) that attacks especially the wattle 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 23 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 is the mold known as *Aspergillus fumigatus* or *niger*. These molds are very common in nature, especially on grain and hay kept in damp places. Crowding chicks in a poorly ventilated brooder house is a predisposing factor that favors the entrance of the mold into the bodies of the chicks. However, the fungus does not confine itself to young birds, but it is found in adults



FIG. 23.—An extreme infection by the *Favus* fungus.

as well. This type of pneumonia should not be confused with that due to infection with pullorum disease, which is very common in incubator-hatched chicks.

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 large yellow necrotic masses from which the organisms may be cultivated.

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 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.

Post-mortem Findings

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.²⁴ This should be given to the birds for one week and discontinued for one week and again repeated for several times.

DISEASES DUE TO PROTOZOAN PARASITES

There are a number of very important poultry diseases due to the action of 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.²⁵ 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.

24. Solutions stronger than this are not consumed readily and birds may be injured if forced to drink them.

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

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 attacks. This is indicated under the heading of immunity in Table III.

The oöcysts are very resistant outside the body. Edgington and Broerman²⁶ found that oocysts 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.

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. 24) 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

TABLE IV.—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. 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. meleagritidis</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. meleagritidis* from the turkey, for each of which only twenty oöcysts were measured. From report by Tyzzer.

chicks will show symptoms at the same time, and generally a few will have a white exudate in the eye similar to that seen in roup. This exudate is caused by the organism getting into the eyes from the feet when they are used to scratch the eye and head. Nutritional diseases may be complicating factors. 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



FIG. 24.—A chick six weeks of age suffering from acute coccidiosis.

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

Since old birds are commonly 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.

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 and preferably three times each day and replacing with fresh litter will do much to correct the condition. 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.

Beach and Davis, of the California Agricultural Experiment Station, recommend a feed containing 40 percent dry skim milk or buttermilk for the control of coccidiosis. The following mixture is fed as the entire ration for a period of time not longer than three weeks:

Dry skim milk or dry buttermilk.....	40 pounds
Yellow corn meal.....	30 pounds
Ground barley or shorts.....	20 pounds
Wheat bran.....	10 pounds

The milk has a laxative action and makes frequent cleaning necessary. It is also high in food value, but has no direct action on the organisms already in the intestinal mucosa.

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.

It has been reported from the Wisconsin station that the addition of flowers of sulphur to hopper-fed dry mash would prevent infec-

tion of chickens by coccidia. A more recent report indicates that the use of more than 2.0 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.

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 thought 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, a tendency to lag behind the flock, 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. 25.) Several poult usually develop symptoms at the same time.

Post-mortem Findings

When a blackhead carcass is examined by post-mortem, the liver and the ceca (blind pouches) should be examined for lesions. Yellowish or yellowish-green areas are seen on the surface of the liver (fig. 26) in most cases, but some do not show these changes. The ceca (fig. 27) are generally impacted with a thick mass of foul-smelling necrotic material and the inner surface map show an ulcerated condition. The ulcers may be large or small and may perforate the wall of the cecum and lead to peritonitis.

Control

Treatment of blackhead is of little value, the only hope lying in prevention. 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. 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 and give each ten days until the birds are ready for 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.



FIG. 25.—Typical position of a turkey affected with blackhead disease. (The position and the sulphur-colored droppings are usually diagnostic of blackhead.)

Other preventive measures that should be observed are: Do not let chickens and turkeys 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 flock; and do not feed the poults on the same area for long periods of time, since the soil is apt to become heavily infested with the causative organism and thus be a continual source of fresh infestation. Eggs for hatching should be purchased 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 treatment of roundworms (page 94), 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. 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

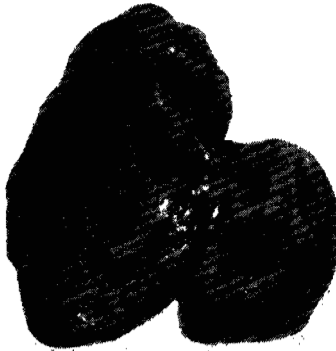


FIG. 26.—Liver from turkey affected with blackhead showing irregular yellowish areas on the surface.

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. H. M. Scott, 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. 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.²⁷ Some modify this system of complete confinement by furnishing a small run in front of the brooder house. To successfully use this modification it is necessary to place an eight-inch layer of clean river gravel over the entire ground area of the run or con-

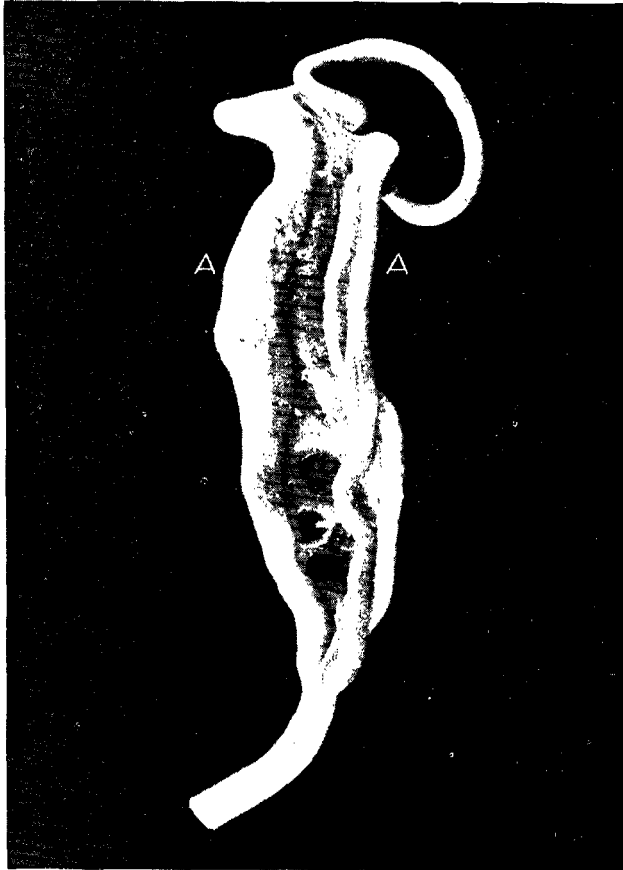


FIG. 27.—A portion of the intestines showing swollen and ulcerated ceca (A) (blind pouches) characteristic of blackhead. Note the large areas of ulceration on the left caecum.

struct 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

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

separate and distinct 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. Turkeys do not need a large area over which to roam if the ground is clean. Green 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.²⁸ The poults are brooded 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 sand or gravel as a litter on the brooder house floor.
3. During the first 12 weeks feed mash only. This should be before the poults at all times in open hoppers.
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. — This disease, sometimes referred to as “flagellosis,” 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.

²⁸. For specific recommendation on feeding of turkeys, the reader is referred to the Department of Poultry Husbandry at the college.

The organisms are actively motile by means of three to five flagella. *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.

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

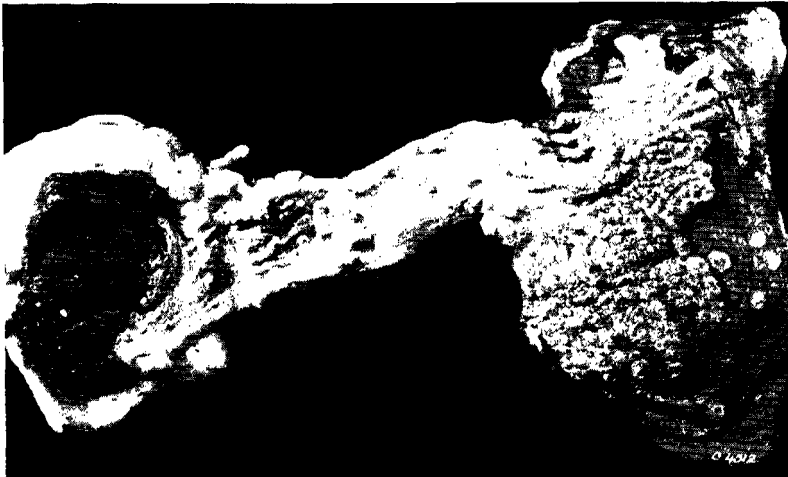


FIG. 28.—Showing trichomonas infection of the crop and proventriculus of the turkey. Note areas of ulceration.

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. The ceca may be somewhat enlarged and filled with a thin, slimy fluid. 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.

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. The feeding of sour milk has been recommended.

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.

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.

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. This insect develops most rapidly in July and August.

Symptoms

Mites cause severe irritation to the host, but seldom leave any mark. Unthriftiness 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 crude carbolic acid, creosote oil, carbolineum, or sheep dip is usually sufficient to reduce the action of mites to a minimum. An occasional treatment of the roosts with Black Leaf 40 is also very effective. The fact should be kept in mind that mites are bloodsucking 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. (Fig. 29.) 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



FIG. 29.—The leg of a chicken as it commonly appears in scaly leg.

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 unthriftiness, "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 Bugs*"). — 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 infested 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 infest the birds. Occasional dusting with flowers of sulphur will also tend to keep the mite from infesting the chicks. Fenced-in ranges may also be dusted with very finely ground flowers of 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 (*Tropical*). — The tropical mite (*Liponyssus bursa*), 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 or flocks. Unlike the red mite the tropical 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 the nests and on the 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. Production and growth are naturally very seriously impaired.²⁹

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 a 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 fluoride seems to be the best general remedy. Bishopp and Wood recommend dipping the birds in a solution of sodium fluoride as follows: The dip is made in a tub in the proportion of one ounce of the commercial, or two-thirds ounce of chemically pure sodium fluoride 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

29. 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.

feathers and wet the body. Finally, duck the head of the bird a few times, drain for a few seconds, and release. One pound of sodium fluoride will be enough to treat 300 hens when using the dip method.

As it is unsafe to practice the dipping method except in warm weather, the "pinch" system of treatment with sodium fluoride is also used and gives excellent results.³⁰ A pinch of sodium fluoride is taken between the thumb and forefinger and placed on all affected parts—under the wings, on the head, etc. 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 that may fall off in applying can be recovered. If many birds are to be treated one's eyes and nostrils should be protected, for the drug is somewhat irritating. One pound of sodium fluoride will treat 100 birds when the pinch method is used.

Sodium fluoride 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.

Others have recommended the use of sodium fluosilicate as being more effective and less expensive. It is applied in the form of a powder in the same manner as described for sodium fluoride.

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

Nicotine sulphate in the form of Black Leaf 40 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. 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 crank-case 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 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 tropical mite at least, three treatments are necessary.

Great care must be exercised in using products containing nicotine 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.

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

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. 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 deposits 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.³¹ 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. 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.

DISEASES DUE TO WORMS

There is probably no group of parasites so injurious to poultry as the 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 recom-

31. Bishopp, F. C., and Wagner, R. D. Nicotine in the control of Ectoparasites of poultry. Jour. Econ. Ent. 24, p. 56. 1931.

mended. 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 mansoni*) 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.). Sanders³² has found the larvae imbedded in the adipose tissue and free in the body cavity of those roaches. The worm larvæ 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 in the tear sac of the eye and under the nictitating membrane (thin membrane). Here they may set up an inflammation leading to excessive secretion of tears and irritation. 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 dropping 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, 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

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

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% solution in linseed oil. Within three days the parasites are loosened and coughed up. 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 round-worms 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.³³ There are several species. They have been reported from the chicken, turkey, pheasant, pigeon, duck, goose, and several wild birds. *Capilluria annulatu*, *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 some-

33. 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.

times 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, 3 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.³⁴

Carbon tetrachloride in 1.0 cc. doses, has been found effective for certain kinds of capillaria. This dose should be repeated twice at 10-day intervals.³⁵

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

34. 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.

35. See page 94 under Roundworms.

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 cc. amounts has been recommended for adult birds. Continuous feeding of tobacco dust at the rate of 1.0 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.

Roundworms.— Two other important species of roundworms are common in Kansas chickens. The large roundworm, *Ascaridia lineata* (fig. 30), 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 block 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.

Ackert³⁶ 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 is due to infestation 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.³⁷

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.

Control

The California Agricultural Experiment Station recommends the following treatment for roundworms: Mix two pounds³⁸ 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

36. Ackert, J. E. Parasitologist, Kan. Agr. Expt. Sta. Personal communication.

37. 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.

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

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 can be kept clean and the coops cleaned often, thus minimizing the danger of reinfestation.

Graybill and Beach³⁹ have recommended the use of carbon tetrachloride for the cecum worm and large roundworms. It is most conveniently and safely administered in 1c. c. gelatin capsules. The dose for an adult bird is 3 c. c. They found that the rectal injection

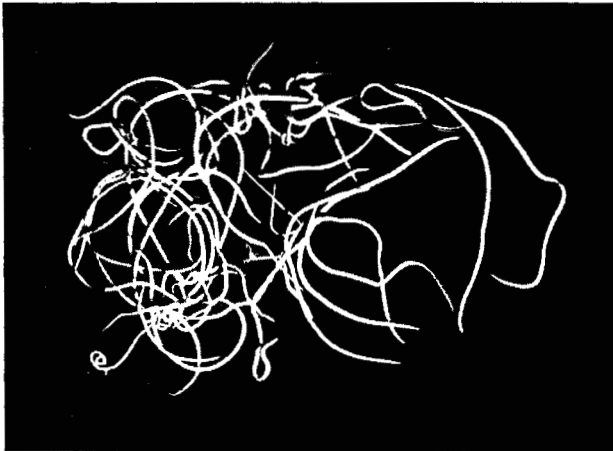


Fig. 30.—Roundworm parasites (*Ascaridia lineata*) from small intestines of a chicken.

of from 5 to 15 c. c. gave approximately 60 percent efficiency in removal of cecum worms, with complete failure in some cases.

Freeborn⁴⁰ 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 c. c. (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 Shillinger⁴¹ recommend oil of *Chenopodium* and olive oil injected into the ceca, via the rectum, to control cecum worms.

39. 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.

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

41. 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 cotton seed 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 slowly injected. This procedure is as easy as giving treatment by mouth, and can be given just as quickly.

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 c. c. of this mixture by mouth before the morning feed.

Many other treatments have been recommended, but the above seem to be giving 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 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.^{42 43}

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.

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. (Fig. 31.) 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 always examine organs in a good light.

The *Raillietina cesticillus* (10 to 50 mm. long by 2 mm. broad); *Raillietina tetragona* (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

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

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

are also found in other species of birds. These forms have beetles, earthworms, houseflies, etc., as recognized intermediate hosts.⁴⁴

Symptoms

The symptoms of tapeworm infestation in birds (Fig. 32) resemble those shown by birds infected with roundworms, and in addition



FIG. 31.—Intestines of chicken showing nodular taeniasis due to the action of *Raillietina echinobothrida*, a certain kind of tapeworm. (A) The ceca (blind pouches). (B) Pancreas. (C) Nodules on small intestines.

nervous conditions are often noticed. Wryneck is common, and the bird in this condition often continually holds its head to one

44. 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 house fly; other tapeworms have other intermediate hosts.

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



FIG. 32.—(A) A chick three months old heavily infested with tapeworms. (B) A portion of the intestines of chick A.

this laboratory assumed a typical penguin-like posture. (Fig. 33.) 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.

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 care-



FIG. 33.—Penguin-like posture assumed by a young bird heavily infested with tapeworms.

ful attention to destruction of droppings and refuse in 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.

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.

Although kamala has not proved satisfactory it is still recommended as of some value for the removal of tapeworms of poultry. Fifteen-grain tablets of crude kamala are given to vigorous, mature chickens, while for immature, weak birds, and those heavily infested with worms, 7½-grain individual doses are recommended. Similar amounts are recommended for turkeys. The kamala tablets in the proper size for individual treatment of poultry may be obtained from a veterinarian or druggist. The tablets are readily swallowed if they are placed well back in the fowl's mouth.

For the best results the kamala treatment should be repeated in three or four weeks, since it does not remove the tapeworm heads which are embedded in the intestinal lining. Kamala will cause a considerable drop in egg production for a week or two following its use, while very weak or heavily infested birds may die.

Another 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 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 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. (Fig. 34.) 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 results. The method used is to dissolve 0.1 grain of the drug in 4 c. c. (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 tape-



FIG. 34.—A bird being given medical treatment by means of a pipette made from glass tubing.

worms. 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.

Chandler⁴⁵ 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.

Skin Flukes.⁴⁶—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.

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

46. 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 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.

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,⁴⁷ 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.

47. 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.

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 there are ulcerated patches on the comb.

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.

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 poisoned by use of poisoned bait.

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, and if death is caused by sprays some of the material may be found.

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 or birds suffering from tapeworm infestation, so that they develop feathers slowly, may become badly sunburned. Such birds must be given adequate shade.

Sod Disease.⁴⁸—Sod disease, vesicular dermatitis, is commonly found in young chicks that have free range of heavy sod lands. It is characterized by a severe swelling of the feet, resembling bumble-foot 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. (Fig. 35.)

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.

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 mixture⁴⁹ 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 rheuma-

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

49. A condition known as slipped tendon, "perosis" (maimed) may develop in brooder chicks fed on mash containing too much mineral and corn. This causes an irregular development of bone tissue. Fig. 12.

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



FIG. 35.—Lesions on feet of a young chick, a typical case of sod disease.

The common causes of the condition are jumping from high perches to hard cement floors, roosting on too narrow perches, continuous walking on bare cement 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.

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.

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 their 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.

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.

Two types of tumorlike conditions have already been discussed, the leucosis (leukemia), and neurolymphomatosis. See page 42. 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 (fig. 34), 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.

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 under 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 sustained.

Control

Ward and Gallagher⁵⁰ 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

50. Ward, R. A., and Gallagher, B. A. Diseases of domesticated birds. 333 pp. Figs. 69. The Macmillan Co. New York. 1922. (Ref. p. 165.)

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 the fertility of the eggs 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 should also 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.

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 “eggbound” 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, grease 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 beak 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 by using a knife 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.



FIG. 36.—Posture commonly assumed following rupture of the oviduct.

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.

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 but 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 (Fig. 36). 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 fifteen years birds suffering from this disease have been received at this laboratory from 448 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 be distributed over the organs and walls. Here it usually becomes thickened and somewhat dry. In the oviduct the ruptured ova are not passed out because the contracting muscles of the organ cannot act upon it. 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 organism may be isolated from the internal organs. Hoffman found that 48 percent of the birds examined exhibited this infection.⁵¹

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 cement 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

51. Hoffman, H. A. Studies on the etiology of "ruptured yolk." Poultry Science 12-189. 1933.

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 is red at first, but later becomes more yellow and grayish in color. In some cases the liquid within the wattle becomes caseated (cheeselike) 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. Davis⁵² 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 com-

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

pound 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.

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 the rest 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.

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. It may be that this change satisfies the craving for some deficiency in the corn. 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.

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 mind 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. Parasites of the skin may cause itching which will 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. Klee⁵³ reports that blood in a cooked form mixed with bran and curd aids in satisfying the craving for blood which is often the cause of birds' pulling feathers. Increasing the amount of oats in the mash is said to correct this habit.

SOME THINGS WHICH KILL YOUNG CHICKS

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.

53. Ward and Gallagher (loc. cit.), p. 177.

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.

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. Feed only clean, pure 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 elements in the feed. 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. The lack of vitamin A leads to ophthalmia, loss of balance, and rapid death. Cod-liver oil, yellow corn, and alfalfa leaves provide vitamin A in large quantities. Lack of vitamin D causes leg weakness (rickets). Vitamin D is supplied by feeding cod-liver oil and by proper exposure to the sun's rays. 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 and lead to cannibalism. 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 in 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.

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 has been discussed earlier.

APPENDIX

Approximate Equivalents.—

- 60 grains = 1 dram = 4 grams = $\frac{1}{8}$ ounce.
- 8 drams = 1 ounce = 30 grams.
- 12 ounces = 1 pound (apothecaries') = 372 grams.
- 16 ounces = 1 pound, (avoirdupois) = 453 grams.
- 1 level teaspoonful of copper sulphate = 9 grams.
- 1 level teaspoonful of crude catechu = 3 grams.
- 1 level teaspoonful of copperas = 8 grams.
- 1 level teaspoonful of nux vomica = 2.5 grams.
- 1 level teaspoonful of potassium permanganate = 11 grams.
- 1 level teaspoonful of Epsom salts = 8 grams.
- 1 gram of potassium permanganate = Amount that will stay on a five-cent piece.

- 60 minims = 60 drops = 1 fluid dram = 4 c. c.
- 8 fluid drams = 1 fluid ounce = 30 c. c.
- 16 fluid ounces = 1 pint = 500 c. c.
- 8 pints = 1 gallon = 4,000 c. c.

- 1 teaspoonful = 1 fluid dram = 4 c. c.
- 1 dessertspoonful = $2\frac{1}{2}$ fluid drams = 10 c. c.
- 1 tablespoonful = 4 fluid drams = 16 c. c.
- 1 teacup = 4 fluid ounces = 120 c. c.

Percentage Solutions.—To estimate the weight of a drug required to make a solution of a definite percentage, multiply the weight of the solvent by the percent desired.

Table of Solutions

1 fluid ounce of water.....	30.0 grams.
To make 1 fluid oz. of a 1 to 1,000 (0.1 percent) solution add..	0.03 grams.
To make 1 fluid oz. of a 1 to 500 (0.2 percent) solution add..	0.03 grams.
To make 1 fluid oz. of a 1 to 250 (0.4 percent) solution add..	0.12 grams.
To make 1 fluid oz. of a 1 to 200 (0.5 percent) solution add..	0.15 grams.
To make 1 fluid oz. of a 1 to 100 (1 percent) solution add..	0.3 grams.
To make 1 fluid oz. of a 1 to 50 (2 percent) solution add..	0.6 grams.
To make 1 fluid oz. of a 1 to 20 (5 percent) solution add..	1.5 grams.
To make 1 fluid oz. of a 1 to 10 (10 percent) solution add..	3.0 grams.

To make one quart of any of the above percentage solutions, multiply the amount required for one fluid ounce by 32.

To make one gallon of any of the above percentage solutions, multiply the amount required for one fluid ounce by 128.

To make one gallon of wine-colored potassium permanganate solution add one gram (the amount which will stay on a five-cent piece conveniently).

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 ⁵⁴ | 1% 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 Halpin⁵⁵ using formaldehyde. The vaseline is placed in a closed jar and melted in a water bath. To this is added 5.0 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).

54. The carbide waste from acetylene tanks can, if available, be substituted for the hydrated lime.

55. 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.⁵⁶ 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 c. c. 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.⁵⁷ The formalin was absorbed by squares 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 c. c. (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.

56. 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.

57. 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 1¾ dr.	2½ dr.
Strychnine sulfate	0.25 to 0.5 gr.	2 gr.	3 gr.
Sulphocarbolate of calcium	¼ to ½ gr.		
Sulphocarbolate of sodium	¼ to ½ gr.		
Sulphocarbolate 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

The following special articles of equipment (fig. 37) are necessary for drawing blood for the standard tube and rapid serum test:

1. Small sharp-pointed scalpel (D) or knife.
2. Leg bands (B) for each fowl to be tested.
3. One dram homeopathic, or shell vials (C and E), for collecting samples.

4. Corks to fit, and labels (A) for marking.
5. Clean towel or piece of cloth for cleaning instruments, before proceeding with the next bird.

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. A good way to do this is to hold the bird against the left side of the body (fig. 38A) and use the left hand to spread the right wing full width and in a vertical position as indicated.

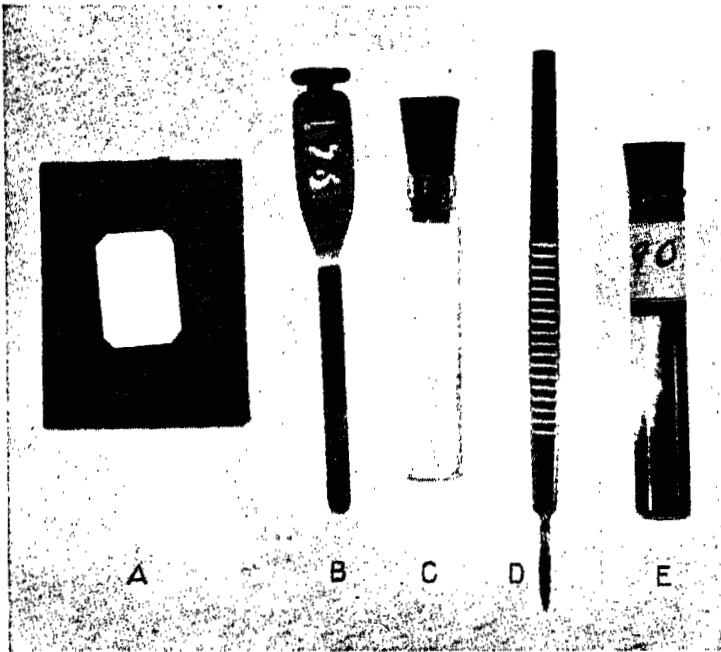


FIG. 37.—Equipment necessary for drawing blood for pullorum disease tests. (A) Gummed labels. (B) Leg band. (C) Vial for receiving blood. (D) Scalpel for puncturing wing vein. (E) Vial ready for shipment.

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.
5. Collect the blood immediately in the vial. *Fill at least one-half full.* Cork tightly and label with the leg band number. An indelible pencil is more



FIG. 38.—Pictures illustrating method of bleeding birds for pullorum disease test. (A) Method of holding bird. (B) Method of puncturing wing vein. (C) Method of collecting blood in vial.

efficient for this than a fountain pen, since ink may blur. *Be sure to write figures plainly and correctly.*

6. Place the vial flat on its side and allow the blood to clot.
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 boiling water for ten minutes. Dry in a hot oven.)
2. If the blood is to be shipped 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, (Vials shipped from this laboratory are ready to be used without further treatment.)
3. Have the skin dry at the time of taking the blood.
4. Thoroughly wipe the instrument used for cutting the vein after 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 let water 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

1. Small sharp-pointed knife or scissors.
2. Clean towels.
3. A glass plate or a white opaque glass ruled in inch squares may be used.⁵⁸
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.⁵⁹
5. Stained antigen (test fluid). This may be obtained only from certain dealers who are authorized to prepare and sell it.

⁵⁸. 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.) A complete equipment may be obtained from many poultry supply-houses. Such complete outfits should be purchased if much testing is to be done.

⁵⁹. A 24-gauge nicrome wire bent into a loop ⁸/₁₆ inches in diameter has been recommended as most satisfactory. This will transfer approximately 0.02 c.c. of blood.

PROCEDURE

1. Transfer a small drop of the stained antigen to each square on the ruled plate.⁶⁰

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 blood heat is used—about 100° F.—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 with the loop.)

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.

One of the difficulties met in this test is the failure to distinguish between the clumped antigen, which is colored, and the clumps of fibrin, which remain nearly white.

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 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 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.

The tests 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.

60. 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.