Pullorum Disease of Poultry

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Oregon State College • Corvallis

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PULLORUM disease has been commonly referred to as B.W.D., bacillary white diarrhea, or contagious white diarrhea. These descriptive names tend to mislead poultrymen concerning the symptoms of the disease since outbreaks often occur without the symptom of diarrhea. The name pullorum disease, which refers to the name of the germ that causes the disease, was adopted a number of years ago and now is universally accepted.

Although progress has been made with the control and eradication of pullorum disease, it is still one of the important poultry diseases for which diligent effort is needed for effective control and eradication. Further, the turkey industry has found the disease of increasing importance since the infection was first found in turkeys several years ago.

This publication is offered to bring up to date our information and knowledge concerning this disease in chickens and turkeys. It is not an attempt to cover the subject completely, but should serve to present the important aspects of the disease.

Economic Importance

The economic importance of pullorum disease cannot be easily determined since much of the loss from this disease occurs with poultrymen who are least able to sustain such loss and who are not informed on the procedure of determining the true nature of the condition.

This disease has become an important cause for losses among turkey flocks. Immediate attention of turkey breeders and hatcherymen to this problem should do much to check the advance of this disease in turkeys and bring it under control.

The greatest mortality occurs among baby chicks and turkey poults. The mortality is perhaps the least of the losses sustained when we consider the loss incurred by unbalancing the proportions of chicks or poults to equipment and labor and the eventual reduction in number of laying fowls available for replacement, or turkeys matured for market. Other losses are: greater percentage of cull birds, decreased egg production, increased mortality among mature fowls, and lower hatchability.

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Nature of the Disease

Cause

The cause of pullorum disease is a specific bacterium (*Salmonella pullorum*) that can be isolated and distinguished from other bacteria when proper bacteriological methods are employed in the laboratory. Faulty management practices such as chilling, overheating, and improper feeding cannot produce the disease. Nor are these conditions necessary for the disease to develop.

An erroneous opinion prevails that losses in pullorum-infected chicks will not occur if they are properly fed and cared for during the early weeks of brooding. Severe losses from pullorum disease in chicks brooded under good conditions by poultry raisers of unquestionable ability and experience should discredit this opinion.

Over-heating, chilling, improper feeding, and other faulty management factors may cause a higher mortality with pullorum-infected chicks than with noninfected chicks under the same unfavorable circumstances. It should not be forgotten, however, that the primary cause of pullorum losses in brooder chicks is the infection.

Infection in chicks

Chicks hatched from eggs containing the germ develop the disease. Infected chicks expose other chicks in the same incubator and brooder. Chicks are most susceptible during the first few days of their lives, and will contract the disease quite readily at this age. After the first few days of life, however, they show a much higher degree of natural resistance to infection. This probably accounts for the fact that a group of healthy chicks, hatched separately, may show a slight or no loss from pullorum disease when placed in a brooder with infected chicks several days after hatching.

The death loss chiefly occurs during the first three weeks after hatching. This loss usually reaches its peak during the second week. Occasionally death occurs considerably beyond this period; this is more often true in turkey poults than in chicks. Autopsy records at the Oregon State College poultry disease laboratory show that of all the cases of chicks under four weeks old submitted for post mortem examination, over 50 per cent had pullorum disease. Some infected chicks survive the infection and the germ may then localize in some organ, usually the ovary in females. These chicks may develop to maturity and present the outward appearance of normal fowls. Such mature fowls, if kept as breeders, may then transmit the infection, through the egg, to their offspring.

Infection in mature hens

Most infected mature hens appear healthy although they maintain localized infection in chronic lesions within the body. Infection

in mature hens has been found localized most often in the ovary, although the disease has been observed in other organs. Although generalized pullorum disease occasionally affects a mature hen, the symptoms and lesions are not characteristic and may be confused with those of other septicemic diseases.

Inheritance of susceptibility and resistance

It has been regularly observed that most of our common heavy (American and Asiatic) breeds of chickens are inherently more susceptible to pullorum disease than are the light (Mediterranean) breed. This should not be considered as a criticism of the heavy breeds. Rather it should emphasize the importance of buying this type of stock only from poultry producers who maintain a sound pullorum disease control program.

Investigations have shown that a degree of high or low susceptibility to pullorum disease can be inherited. These investigations have not shown, however, that it is practical to control and eradicate pullorum disease by selective breeding.

Infection in mature males

Mature males show a much lower percentage of infection than mature females from the same stock. Apparently the germ does not find as favorable a place to live for extended periods in the male as it does in the female. The male, however, should not be overlooked as a possible carrier of this disease.

Infection in turkeys

A number of outbreaks of pullorum disease have been observed among turkey poults in Oregon. The nature of the disease in turkey poults is much the same as the disease in baby chicks. It is evident that newly-hatched turkey poults are highly susceptible to this infection. Mature turkeys have not shown the general tendency to become chronic carriers of the infection to the same degree as do mature chickens. However, available evidence shows that some mature turkeys do become chronic carriers and that this type of chronic carrier may increase in the turkey flocks of the state and nation.

Transmission of Infection

Egg transmission

Infected laying fowls commonly harbor the germ in the ovary, the organ which produces the yolk of the egg. As a consequence, the germ may be contained in some of the normal-appearing yolks as well as in those that are visibly affected.

The percentage of eggs laid by infected females that are carriers of the germ is highly variable. It may vary from birds that lay only an occasional infected egg to birds that lay almost 100 per cent infected eggs. This factor is an important reason for variations in the appearance of the disease in different hatches from the same breeding stock. One of the most important means of transmitting this disease is from pullorum-infected breeders through the egg to the chicks hatched from such eggs. This type of transmission is important not because most chicks become infected in this manner, but because a few chicks infected in this manner are a serious source of infection for other chicks with which they are in contact. The transmission through the egg is the most important link in the cycle of infection by which the disease is perpetuated.

Incubator transmission

Infected chicks or poults may spread infection to noninfected birds in the incubator through droppings, dried egg membranes, and lint released from the down. Infected material may be eaten by noninfected birds, or dried infected particles that are air-borne may be inhaled, especially in the air of forced-draft incubators. This type of transmission is more serious and rapid when the humidity in the incubator is low than when it is high. In undarkened incubators, droppings are more likely to be eaten and thus serve as a source of infection.

A system that involves continuous operation with simultaneous incubation and hatching in the same compartment, increases considerably the seriousness of incubator transmission. This would not be a factor if the eggs were from breeding stock free of infection.

The difficulty may be lessened by incubating in one compartment and hatching in another which is completely separated, or incubating in one machine and hatching in another. But this does not prevent the germ from being distributed among the chicks of any given hatch. It merely prevents transmission from one hatch to the next, provided thorough cleaning and fumigation of the hatching compartment is carried out between hatches. It will expose fewer chicks if the eggs are separated into smaller lots for hatching in separate units. In brief, the serious transmission of the infection in the incubator is at hatching time.

Brooder transmission

One of the common means of spread among brooder chicks and poults is through eating infected droppings. This is less likely to occur if the newly-hatched chicks or poults are kept in a dark place until fed. The droppings from infected stock also contaminate the

chick boxes and provide a means of infecting subsequent hatches if the boxes are used again. The brooder house and equipment may also become contaminated with infected droppings that might be responsible for infecting chicks or poults brooded in such quarters provided they were not properly cleaned and disinfected.

Infected infertile eggs from the incubator may be a very serious source of infection when fed to chicks or poults in the brooder. If eggs or egg shells are to be fed they should be sterilized by being held submerged in boiling water for over sixty minutes.

Among mature fowls

While infection may spread rapidly among chicks or poults during the first few days after hatching through association with infected ones, mature stock under average conditions do not readily contract the disease. It has been demonstrated repeatedly, however, that the infection is transmissible from one mature bird to another.

The rate of spread among mature birds may vary greatly, but on an average it may be expected to spread rather slowly. Very heavy infection of mature stock has been reported following the feeding of uncooked, infertile eggs from the incubator. Eating floor-eggs or droppings from infected birds in a flock may also spread the infection.

Among turkeys

Most of the same means by which the infection is spread among chickens will also apply to turkeys. Only in recent years has this infection caused concern to turkey growers. Most investigators agree that one of the important sources of infection for turkey poults has been the promiscuous hatching of turkey eggs in hatcheries in which infected chicks have been hatched. Since this is a relatively recent infection in turkeys, and one that may increase, special consideration should be given to prevent this important means of spreading infection to turkeys. It is advisable, therefore, to provide complete separation for chicken and turkey hatching operations.

Among animals other than chickens and turkeys

Many reports show that infection of pullorum disease has been found in numerous other birds such as ducks, pheasants, quail, blue jays, sparrows, and the European bullfinch. This infection has also been reported in rabbits fed on eggs that had not been properly sterilized. The chances that wild animals are likely to transmit the infection to commercial flocks of poultry is rather remote. This factor must be taken into consideration, however, when it is desired to establish and maintain a pullorum clean flock.

Symptoms

In mature fowls

Most infected mature fowls appear normal and show no symptoms or outward evidence of the disease. When an occasional bird does become sick from pullorum infection symptoms are not characteristic and may be confused with other common poultry diseases. The common belief that diarrhea or soiled vent fluff indicates infection is misleading.

In baby chicks and poults

The disease in young chicks or poults is usually an acute generalized infection. The affected birds become sick and show symptoms which are not specifically characteristic of pullorum disease. At the beginning of an outbreak affected birds may die very suddenly before symptoms have a chance to develop. After a day or so of sudden losses some of the affected birds will survive for longer periods.

Common symptoms are droopiness, constant cheeping, and a tendency to huddle together or seek more heat under the hover. They may also develop a diarrhea which results in "pasty vent." This is neither a constant nor dependable symptom for diagnosing the disease, however, since there are other diseases that may produce the same symptoms.

Losses during an outbreak may vary from a few to over 50 per cent. The average loss in pullorum infected broods of chicks in Oregon is about 10 to 15 per cent. When chicks are healthy and properly cared for the average natural loss during the brooding period should be less than 5 per cent. When excessive losses occur during the first two or three weeks of the brooding period one may reasonably suspect this infection.

Lesions

In mature fowls

The germ that causes pullorum disease appears to have a special affinity for the ovary of the female. Because of this affinity, lesions are found most often in the ovary of the female. The appearance of typical lesions in the ovary are quite characteristic and may lead to a reasonably accurate diagnosis at autopsy.

Typical lesions in the infected ovary appear as blighted yolks that have long cord-like attachments. The affected yolks may vary in size from a tiny pinhead to that of a full sized yolk. They appear malformed or angular in shape and are often discolored. The color usually is cream to light brown often with a mottled appearance. The

yolk content is usually of a semisolid consistency like cream cheese and there is often a small amount of an oily liquid around the semisolid content. This oily liquid is light amber color somewhat like linseed oil. Characteristic lesions in the ovary are shown in Figure 1.

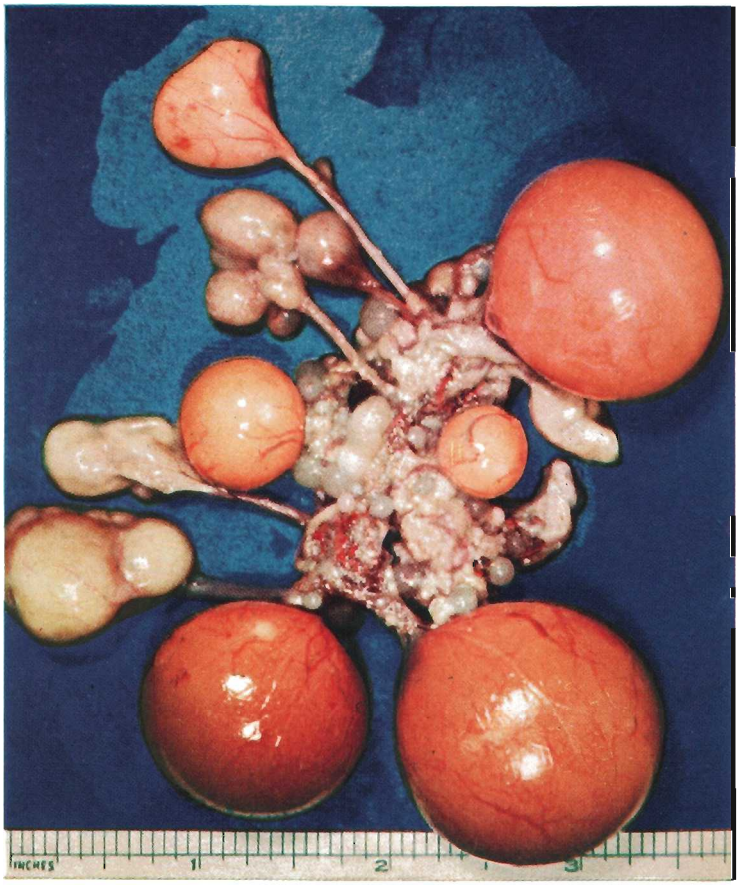

Figure 1. Ovary or "yolk bag" from a chicken affected with pullorum disease. Yolks visibly affected are those with long string-like attachments and angular irregular shapes.

There may be other forms of blighted yolks due to diseases other than pullorum disease. The character of such blighted yolks, however, is usually different from that of the typically pullorum infected yolks.

A small percentage of the cases may have lesions on the heart and pericardial sac. The pericardial sac may contain turbid liquid or cheese-like flakes and the wall of the heart sac is often thickened and opaque. There often are adhesions between the wall of the heart and the heart sac. There may be some enlargement of the heart and the pericardial sac when infection is present. Heart lesions may be caused by other infections, although pullorum infection is most frequently the cause for such lesions.

In chicks and poults

Chicks and poults that have died of pullorum disease often show no lesions that are characteristic of this infection. Therefore, the lack of lesions in chicks and poults should not cause one to assume that pullorum disease is not the cause for loss. Post mortem examination of infected chicks may reveal lesions in the lungs and ceca (blind pouches) that are quite typical of pullorum disease (Figures 2, 3).

Lung lesions are characterized by formation of yellowish abscess areas of various sizes. The lesions may involve one or both lungs. The cecal lesions appear as solid cheese-like cores that take the shape of the cecum. They may be found in one or both ceca. Lung and cecal lesions similar to the ones described may be caused by other diseases. When these lesions are found in chicks under 2 weeks old, however, the chances that the lesions are caused by pullorum infection is greatly increased.

Although lung and cecal lesions in turkey poults may indicate pullorum infection there are other infections that may result in similar lesions. Therefore, in turkey poults at any age the appearance of lung and cecal lesions has not been as accurate an indicator of pullorum infection as these same lesions found in baby chicks.

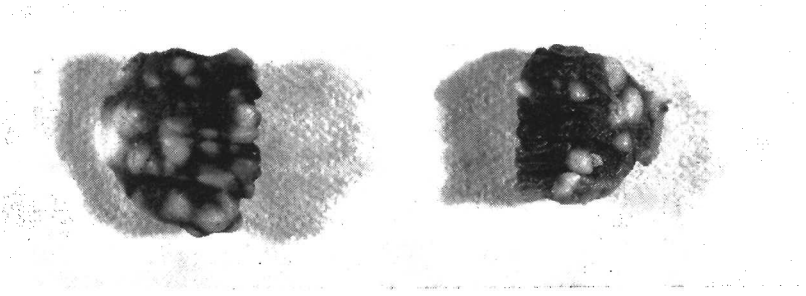

Figure 2. Lungs from a baby chick affected with pullorum disease. The pale areas are cheese-like abscesses caused by the pullorum organism.

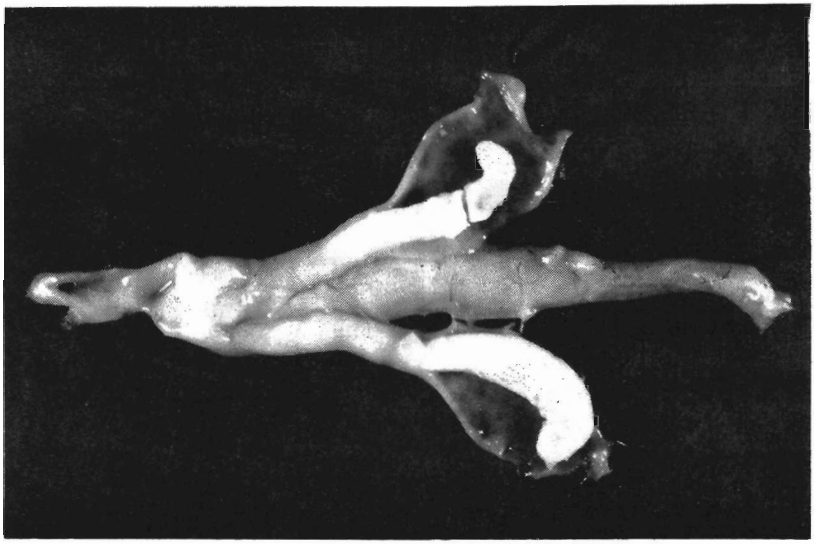

Figure 3. Ceca or "blind pouches" from a baby chick affected with pullorum disease. The blind ends of the ceca have been cut open showing the firm, cheese-like, caseous cores indicative of pullorum disease.

There are a number of lesions erroneously thought by poultrymen to be indicative of pullorum infections, such as distended gall bladder, "yolkers," and "pasty vent." Although these lesions may be found in some chicks with pullorum infection, they are not associated with the infections often enough to be used with any degree of accuracy as an indicator of pullorum infection.

Diagnosis

Although symptoms and lesions may suggest very strongly the presence of pullorum disease they can not be entirely relied upon for an accurate diagnosis. For a reliable diagnosis it is necessary to make a post mortem and bacteriological examination, and recover and identify the germ that causes pullorum disease. Such an examination can be made only in a properly equipped laboratory.

Baby chicks or turkey poults suspected of suffering from pullorum disease may be sent to:

OREGON STATE COLLEGE
DEPARTMENT OF VETERINARY MEDICINE
POULTRY DISEASE LABORATORY
CORVALLIS, OREGON

Four to six birds showing typical symptoms of the illness should be submitted for examination. Dead birds from under the hover should not be sent as they are likely to be decomposed. Neither should active, healthy appearing birds be sent as they may not have the infection. The possibilities of an accurate diagnosis will be increased if sick birds are selected and an examination made as soon as it is evident that a disease is in the brood of birds. Sending specimens for examination after the acute stage of the disease is over and losses have subsided may prove of little value since it often is not possible to recover the pullorum organism from such birds. Whereas, if the birds are submitted during the acute stage of the disease the organism may be readily recovered.

Treatment

In recent years the use of various sulfonamide drugs has been helpful in reducing the mortality during outbreaks of pullorum disease in both chicks and poults. However, the true value of these drugs in acute outbreaks remains to be established. The value of the drugs in reducing mortality may be offset by keeping alive birds that become unthrifty culls or infected pullorum carriers that will have to be disposed of at a later date. Only time and further studies on the value of the sulfonamides will give us the answer to such questions.

When sulfonamide drugs are used on cases of pullorum disease it is very important that these drugs be used according to the specific directions. Misuse of sulfonamides may easily result in a toxic effect.

Control and Eradication

To prevent the occurrence of pullorum disease is the objective of the control and eradication program. The basis of this program is an intelligent use of blood testing plus a sound program of breeder-flock management and hatchery sanitation. Complete eradication of pullorum disease should be the goal in all hatcheries and breeding flocks of chickens and turkeys.

Blood testing

One of the most important parts of the pullorum disease program is blood-testing the flock. Although there are some differences in the techniques used the basic principle of the agglutination test is the basis for all of the techniques. There are two general methods of the agglutination test commonly used in Oregon. One is the

serum-agglutination method which is primarily a laboratory test, and the other is the whole-blood-agglutination method that is used extensively in the field.

Regardless of the method used, one of the most important factors that may influence the accuracy of the testing results is the ability of the person who conducts the tests and reads the results. A knowledge and understanding of pullorum disease and testing procedure, experience in pullorum disease testing, and a moral sense of the responsibility of testing are attributes essential for a good pullorum testing agent.

Testing terms

When a reaction occurs between the blood or serum of a fowl and the test fluid (antigen) such an individual is called a reactor or positive bird and is considered as a bird infected with the pullorum germ. When there is no reaction between the blood or serum and the antigen, the bird is called a nonreactor or negative bird and is considered as a noninfected individual.

Serum-agglutination method

The serum-agglutination method requires the drawing of a blood sample from each bird in the flock. The birds must be banded and each blood sample identified by the bird's band number. The blood is easily obtained from the wing vein without any effect on the health of the bird when bleeding is done properly. (Those who are interested may obtain Station Circular 144, which provides information on drawing blood samples.)

The blood samples are sent to the laboratory for testing. By the time the blood samples reach the laboratory the serum used for testing has usually separated from the blood clot and appears as a light amber-colored fluid beside the blood clot in the tube. The tests conducted in the laboratory may be either the serum-plate or the serum-tube test. Both methods are very accurate in detecting infected chickens or turkeys.

Whole-blood-agglutination method

The whole-blood-agglutination method is conducted on the birds at the poultry farm. It is performed by pricking the wing vein of the bird to obtain a sample of blood. The blood is picked up with a special type of wire loop and is immediately mixed with a drop of test fluid (antigen) on a clean glass plate. The complete instructions for conducting and reading the results of this type of test are provided with each bottle of antigen. Testing agents who operate under the supervision of the Oregon Poultyr Improvement Program receive instructions for testing under the program.

There are several different formulas for making antigen to be used for the whole blood test. However, they are all stained antigens to be used in detecting birds that are carriers of pullorum infection. They are produced by several commercial concerns under license from the United States Department of Agriculture, Bureau of Animal Industry.

Although stained pullorum antigen may be purchased for use by anyone, experience has shown that the accuracy of the whole-blood stained-antigen test will be much higher when it is conducted only by well-trained, experienced testing agents.

When to blood test

Testing may be done at any season of the year. When blood samples must be drawn and sent to the laboratory, however, there is less danger of the blood samples spoiling during the cool fall and winter weather. When blood samples are taken for shipment during warm weather, they should be kept cool.

It is usually advisable to have the testing done each year some time in advance of the period when hatching eggs are to be saved. The chicken and turkey improvement programs state that chickens be "more than 5 months" and turkeys "more than 4 months" old before they may be officially tested. Although birds may be tested at an earlier age it is not recommended because of the greater chance for erratic results of the tests.

Hatchery sanitation

The basis of hatchery sanitation is a sound cleaning and disinfecting program. The method used for disinfection depends on what is to be disinfected. Before proper disinfection can proceed everything to be disinfected must be thoroughly cleaned.

A suction or vacuum type cleaner should be an essential part of cleaning equipment for a hatchery. This provides a most satisfactory means of cleaning up the dust, lint, down, or other loose particles that might become airborne. Vats or tubs large enough for cleaning and disinfecting equipment that becomes soiled with droppings and other contamination that can not be picked up with the suction cleaner should be available.

The pullorum organism is readily destroyed by most of the common disinfectants when they are used properly. Hatcherymen, therefore, may use the disinfectant of their choice for scrubbing and washing.

Formaldehyde is recommended for fumigation of the hatchery compartments when no eggs and chicks are present. For this pur-

pose add 1.5 cubic centimeters of full strength formalin to 1 gram of potassium permanganate for each cubic foot of air space to be fumigated. Those who do not have metric system measuring devices may use 1 tablespoonful of formalin to 2 level teaspoonfuls of potassium permanganate to each 10 cubic feet of air space.

The cubic feet in an incubating or hatching compartment should be figured without allowing for space occupied by trays or other equipment in the compartment. An earthenware container should be used and it should be large enough so that the chemicals will not boil over when they are put together. As soon as the formalin is poured into the container with the potassium permanganate the door of the compartment should be closed. All vents that might allow escape of the formaldehyde gas also should be closed. The incubators should be in normal operation with the heat and humidity up to hatching levels and the fans for forced circulation should be operated so as to distribute the gas properly. The incubator compartment should be kept closed for at least one hour—and for several hours when it is possible to do so.

Fumigation of the incubator compartments while hatching eggs, baby chicks, or poults are present constitutes considerable risk. When such fumigation is attempted one should follow very closely the recommendations of the incubator manufacturer. Under no circumstances should the proportions of formalin and potassium permanganate recommended in the preceding paragraph be used in an incuabtor while it is occupied by eggs, chicks, or poults.

Although emphasis is placed on cleaning and disinfecting the incubators it is important that the room occupied by the incubator be regularly dusted and cleaned especially after each hatch is taken off. This is particularly true when the incubators are of the forced-draft ventilation type. Care should be taken not to neglect cleaning and disinfecting tables, benches, and muslin or burlap covers for the newly-hatched chicks to stand on.

Clean chick boxes are part of the hatcheryman's responsibility. This is no problem when only new chick boxes are used. Reused chick boxes should be thoroughly fumigated after each use and new, clean pads put on the floor of the boxes. The fumigation of the boxes may be done by placing the boxes in the incubator compartment when it is fumigated between hatches. Some hatcherymen have provided themselves with a small tight room in which they can stack the boxes for fumigation. The same proportion of formalin and potassium permanganate previously recommended for incubator fumigation should be used in such a room.

National Programs

In 1935 the National Poultry Improvement Plan was started, and in 1943 the National Turkey Improvement Plan began. Both of these improvement programs have a section that deals with pullorum disease control and eradication. The Oregon Poultry Improvement Plan and the Oregon Turkey Improvement Plan have been cooperating in the national programs since their inception. Most of the hatcherymen and producers of chickens and turkey hatching eggs in Oregon are voluntarily participating in the chicken and turkey improvement programs.

The pullorum disease phase of the improvement programs are designed to help producers control and eradicate this disease. It has the additional value of providing buyers of hatching eggs, turkey poults, or baby chicks with a guide to the pullorum disease status of the breeding flock. It is important, therefore, that buyers understand the meaning of the four stages concerning pullorum disease provided for in the plans. Details of the improvement programs may be obtained by writing to:

STATE DEPARTMENT OF AGRICULTURE
POULTRY SUPERVISOR
208 POULTRY-VETERINARY BUILDING
CORVALLIS, OREGON

Factors Affecting Pullorum Disease Control

Occasionally erratic results are encountered in what appears to be a properly conducted control program. Because of such results some flock owners and hatcherymen lose faith in the value of the programs. A better knowledge and understanding of some of the factors that may cause variable results might prove helpful.

Custom hatching

This practice has been responsible in many cases for introducing and maintaining infection on a poultry farm. Flock owners have been known to carry out a careful blood testing program to eliminate pullorum infection from the breeders only to have infection reintroduced into the chicks by having them custom hatched in infected incubators.

Turkey growers in particular often have been innocent parties to the introduction of pullorum infection into their turkey poults by custom hatching them in hatcheries along with infected baby chicks. This should not be construed to mean that all custom hatching is bad and that the practice should be abolished. This is to draw attention

to a dangerous method of spreading pullorum infection and to urge that greater caution be taken with hatchery sanitation and management where custom hatching is practiced.

Testing accuracy

In the laboratory the testing accuracy can be maintained at a very high level because only well-trained experienced personnel do the testing, and facilities for checking accuracy are readily available and frequently used. In the field the whole-blood stained-antigen method serves a very useful purpose for reducing pullorum infection in the breeder flock. In some individual cases the accuracy of the test has been equal to the laboratory test. Field conditions vary greatly and there are innumerable field testing agents with varying degrees of training and experience, so that on an average the field testing is not so accurate as laboratory testing.

When properly applied, the whole-blood test is highly effective for reducing pullorum infection in the breeder flock. When a flock is to qualify for a clean rating, however, the increased accuracy of the laboratory test is to be preferred.

All field pullorum testing agents should be aware of these factors in the whole-blood test that are important for a high degree of accuracy:

1. **A clean testing plate, free from dust and grease.**
2. **Testing plate at temperature between 60° and 80° F.**
3. **Antigen should be used before the expiration date on the bottle.**
4. **When not in use keep antigen under refrigeration.**
5. **Shake antigen well before using and shake antigen frequently while testing.**
6. **When dropping antigen hold the dropper 1 to 2 inches above the plate. Do not touch the plate with the end of the dropper.**
7. **Hold the dropper so that the drop falls straight away from the end of the dropper. Straight droppers should be held perpendicular to the plate. Curved droppers should be inclined to the angle necessary for the drop to fall straight away from the end.**
8. **For collecting blood, use only the standard wire-loops (3/16 inch diameter) that are provided with the antigen.**
9. **Make certain that the loop is full of blood so that it bulges from each side of the wire loop.**
10. **As soon as the full loop of blood is obtained promptly start mixing it with the drop of antigen on the plate.**
11. **Mix the blood and antigen with the wire loop with at least 15 to 20 revolutions.**
12. **Make suitable provisions for holding birds for 2 minutes.**
13. **Do not read tests that have been mixed longer than 2 minutes.**

14. **Use well directed light for accurate reading of tests.**
15. **Haste in reading reactions and releasing tested birds reduces accuracy of testing and effectiveness of control.**
16. **Testing agents who are confused by unusual and suspicious reactions should submit blood samples or the bird itself to a competent poultry disease laboratory for study. By increasing their knowledge concerning abnormal reactions, testing agents are able to increase their testing accuracy.**

Disposal of reactors

Fowls that are reactors should be removed and disposed of as soon as possible. The longer they remain in the flock the greater the danger of spreading infection to the noninfected birds.

Breeder flock sanitation and management

Where insanitary conditions prevail for a flock of breeders that have some infected birds among them, the chances for eradicating pullorum infection are less.

It is not only important that a reasonable program of cleanliness and sanitation be carried on, but management practices should be directed toward better sanitation. Feed troughs and water fountains should be so arranged and of a type that will prevent wastage. Nests should be of a type and so arranged that the number of floor eggs laid will be kept at a minimum. This will discourage egg eating. Dropping boards should be screened so that the birds cannot get to eggs dropped from the roosts. Since the eating of infected eggs is a means of getting infected, any management practice that will minimize egg-eating should be helpful.

Flock replacements

When a poultry breeding flock has been established as pullorum clean, it may remain so indefinitely provided infection is not reintroduced into the flock. Introducing new stock into a pullorum clean breeding flock should be done only after a thorough investigation to make certain the source from which the new stock is obtained is also pullorum clean. When contest or exhibition birds are returned to the poultry farm they should be held in a quarantine pen for at least thirty days and should pass a negative pullorum test before their eggs are used for hatching. Only new or thoroughly cleaned and disinfected crates or boxes should be used for transporting such birds. To some flock owners this may seem to be an unnecessary delay and expense. But many cases are known where pullorum clean flocks became reinfected because such precautions were not observed. The time and expense involved in obtaining a pullorum clean rating far exceed the expense of precautions.

Misunderstandings

Quite often misunderstandings occur concerning various factors related to pullorum disease control. In some cases misunderstandings have delayed the adoption of a sound pullorum disease eradication program.

There are some who have the mistaken idea that the pullorum test gives a positive reaction because the pullorum germs are in the blood taken for the test. This is not so. Pullorum germs localized in a bird's body cause the production of substances called agglutinins. It is the agglutinins in the blood that cause a positive reaction with the antigen. Therefore, there is no danger of spreading the disease from one bird to another while obtaining blood samples. Pullorum agglutinins are not capable of spreading the disease to other birds.

Variations in mortality caused by pullorum infection in different broods of chicks from the same source of breeding stock has often led to confusion and misunderstanding. In the first place it is necessary to dispel the idea that a mathematically constant number of pullorum infected chicks will come from a given number of infected breeders. There are many factors that may affect this variation in pullorum disease losses. A few of the important reasons are:

(1) Not all eggs laid by infected breeder hens carry the germ. There is a marked variation in the number of infected eggs laid by different infected breeder hens. (2) There are innumerable factors in incubation and brooding that will cause a wide variation in the amount of spread of pullorum infection among the chicks or poults during hatching and brooding. (3) There may be a variation of the virulence of the pullorum organisms involved in different outbreaks of the disease.

Blood testing for advertising advantage is basically unsound. The expressions "blood tested stock" or "100 per cent blood tested" may have no real significance so far as actual pullorum disease control is concerned. Many questions may be raised in establishing whether such statements signify a sound testing program. Answers to these questions may reveal an unsatisfactory program and the statement "blood tested breeding stock," although literally correct, may be misleading. It was natural, therefore, that supervised testing came into being and is now carried on by the state in cooperation with the national poultry and turkey improvement programs. The official terms of U. S. PULLORUM TESTED, U. S. PULLORUM CONTROLLED, U. S. PULLORUM PASSED, and U. S. PULLORUM CLEAN signify that the breeding stock advertised under one of these ratings has been tested and the testing has been done according to a set of regulations for that particular rating. It is against the law for anyone who is not

officially under the program to use any of these official terms in advertising. It, therefore, behooves chick and poult buyers to learn just what the different official terms indicate so far as pullorum disease control and eradication are concerned.

An erroneous opinion prevails that if a few infected birds are left in the flock it will help to keep up the inherent natural resistance to pullorum infection. There is no sound immunological basis for such an opinion and efforts to follow this course will only delay the eradication of pullorum infection.

The feeling prevails with some producers and hatcherymen that it is impractical, if not impossible, completely to eradicate pullorum infection from the breeder flocks. The many clean flocks in Oregon and the increasing thousands of clean flocks throughout the United States are verification of the fact that it is practical to eradicate pullorum disease.