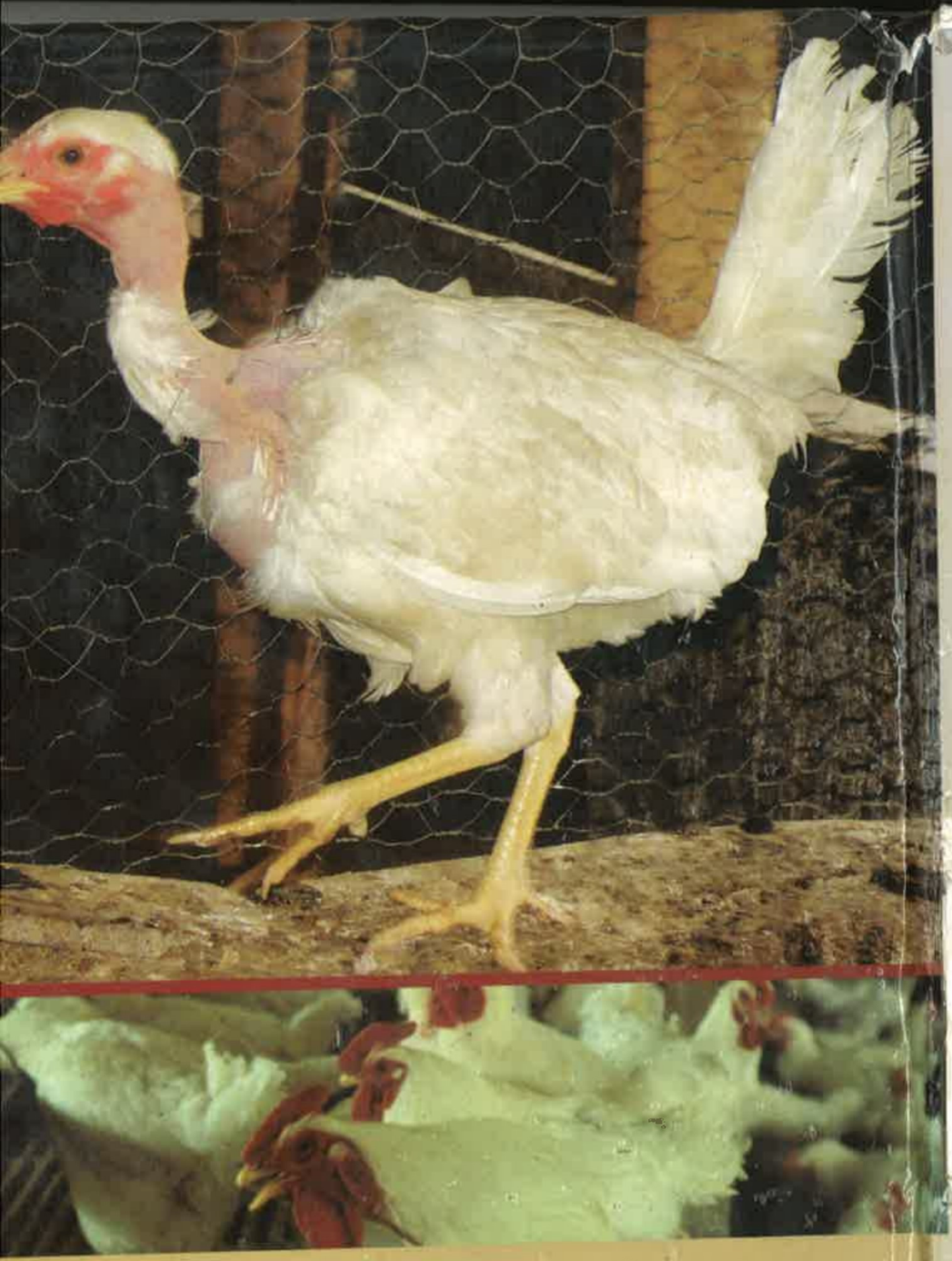
Diseases And Parasites of Poultry

Gove Hambidge



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e book **"Diseases and Parasites of ultry"** divided into 14 chapters:

Pullorum Disease
Fowl Paralysis and Other Forms of e Avian Leukosois Complex
Respiratory Diseases of Chickens and rkeys
Fowl Pox (Diphtheria)
Psittacosis
Miscellaneous Diseases of Poultry
Internal Parasites of Poultry
Coccidiosis of the Chicken
Poultry Lice and Their Control
0. Poultry Mites
1. The Fowl Tick
2. Bedbugs as Pests of Poultry
3. The Pigeon Fly
4. Nutritional Diseases of Poultry

Equally useful as a handy reference source for students of Veterinary courses and also for practicing veterinarians. The book compiles the necessary available information related to various diseases of the Poultry. The text has been aptly illustrated through photographs and a comprehensive subject index have been provided to enhance the utility of the book.

DISEASES AND PARASITES OF POULTRY

Editor
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CONTENTS

INTRODUCTION

Pullorum Disease

The poison-forming germ, *Salmonella pullorum*, primarily attacks the ovaries in hens and may produce no visible symptoms or signs except reduced productivity of the hen and hatchability of its eggs. In chicks, however, it produces a devastating disease, formerly called bacillary white diarrhoea, which may practically exterminate an entire brood within three weeks after hatching. The germ is transmitted through the egg and also in excreta and on bits of contaminated material, such as fluff, floating in the air. The disease is extremely contagious and infectious. Unfortunately, many of the infected chicks do not die but grow up and in their turn produce infected eggs, perpetuating and spreading the malady. Thus pullorum disease has become exceptionally widespread and has been responsible for enormous losses to poultrymen. It is one of the major problems of the hatchery industry, since a few infected eggs in one of the giant modern incubators are a source of danger to the whole hatch.

There is no medicinal cure or preventive for pullorum disease and control depends fundamentally on locating and eliminating all carrier hens. Agglutination tests have been developed that make this possible. Three methods are commonly used, all involving expert skill and labouratory facilities. Bunyea describes them with a degree of detail that gives the layman an insight into the kind of procedures involved in making tests for various diseases.

1. The long method, or tube test, involves taking samples of blood from fowl and sending them in test tubes packed in ice to a labouratory, where the blood serum is mixed with a specially prepared suspension of bacteria, known as an

antigen, derived from cultures of the pullorum germ. In a positive reaction, the bacteria are clumped together and settle to the bottom of the tube, leaving the fluid clear. This method is relatively costly and the other two have been developed in recent years to reduce the expense of testing and bring it within reach of more poultrymen.

2. In the rapid serum test the serum from the blood of the fowl is mixed with a concentrated antigen on a glass plate over an illuminated dark background. In a positive test the bacteria are clumped together and separate in the form of particles or masses that are easily visible, with clear surrounding fluid, whereas in a negative reaction the smear remains uniformly cloudy.
3. The stained antigen, rapid whole-blood test, the most recently developed method, does not require the collection of serum and it can be carried out on the farm. A single drop of blood is mixed with a single drop of antigen, which has been stained with crystal violet, on a white glass plate. In a positive test, the stained bacteria clump together and are easily seen as violet-coloured particles.

With these tests as a weapon and the seriousness of the disease as a motive, a National Poultry Improvement Plan was inaugurated in 1935 to make a concerted drive against the scourge on a countrywide scale. The plan is administered by State officials cooperating with the Federal Bureau of Animal Industry. By 1940-41, 44 States were participating and nearly 9 million birds had been tested. Under the plan, flocks are certified in three classes, U.S. Pullorum-Tested, U.S. Pullorum-Passed and U.S. Pullorum-Clean.

Reports from all over the country indicate that as a result of this plan, the hatchability of eggs is improving and the mortality among chicks decreasing.

Meanwhile pullorum disease has become increasingly important as a menace to the turkey industry. Turkey poults seem to be very susceptible and suffer a high mortality. The tests used for chickens do not give as clear-cut results with turkeys and more work is being done on this problem. The best preventive is to have turkey hatching and brooding done entirely separate from these operations with chickens.

Fowl Paralysis and Other Forms of the Avian Leukosis Complex

Of the $100,000,00 toll taken by poultry diseases every year in the United States alone, about half is due to a disease, or a group of diseases, concerning which science knows comparatively little. The manifestation of this disease complex most familiar to poultrymen is probably fowl paralysis, also called range paralysis, in which the nerves are affected so that the bird is partly or completely paralysed. But there are many other manifestations described in this article by Brandly, Waters and Hall. One type affects the eye, causing loss of colour in the iris, bulging of the eyeball, changes in the size and shape of the pupil and sometimes partial or total blindness. Another, the visceral type, affects the internal organs–liver, lungs, heart, spleen, ovary, testicles, kidneys, intestines–causing loss of flesh, weakness and non-productiveness. In still another type, the long bones become thickened and enlarged. In the blood type, there are alterations in the blood, the circulation and sometimes the bone marrow (source of red blood cells) which may quickly endanger the life of the bird. A dozen or more lengthy scientific names have been applied to these various manifestations, all of which have features that are similar and also are suggestive of certain diseases of other animals and human beings.

Fowl paralysis first appeared in this country about 1920 and in the twenty-odd years since, there has been a good deal of scattered investigation of the avian leukosis complex. Quite recently, in 1938, a Regional Poultry Research Labouratory was established by the United States Department of Agriculture at East Lansing, Mich. and here major attention is being given to this disease group. The work of the labouratory is done in co-operation with 25 States in the North Central and Northeastern States.

What is the cause of the disease complex and how is it spread? No one yet knows. Apparently poor nutrition, an unfavourable environment and parasitic infestation are not causes, though any of them may well predispose birds to attack. Nor have any specific bacteria been found to cause the disease. Most authorities consider that a virus or viruslike agent is responsible. Various types of the disease can be transmitted by inoculating young birds with material prepared from the blood or organs of diseased birds, but how it is transmitted under ordinary conditions has not been discovered.

There are indications that it is passed on through the egg and also by contact. Resistance increases rather rapidly with age and apparently there are inherited differences in susceptibility. All in all, pending further knowledge, the best practical advice that can be given to poultrymen for combating this malady is to use strict sanitary measures in the whole process of raising poultry and to follow careful breeding procedures, mating only birds from blood lines that have a record of good health and high viability and closing flocks to outside breeding.

The authors of this article review much of the scientific work that has been done to date on the avian leukosis complex and then describe in some detail the coordinated investigations being carried on at the regional labouratory. In these investigations, genetics and pathology are receiving major attention at first. Because of the lack of knowledge about the cause of the disease and how it spreads, the physical arrangements at the labouratory involve extraordinary precautions to prevent un-intentional transmission of the disease from one group of birds to another.

In the genetic work an effort is being made to form families inherently resistant and families inherently susceptible to the avian leukosis complex, the latter to be used in pathological studies and also in determining the mode of inheritance of resistance and the influence of the environment. Ten different White Leghorn strains are being used. The pathology programme includes studies on methods of diagnosis, means of detecting carriers, means of transmission, nature and tissue distribution of the causative agent, embryo and chick susceptibility and the mechanism of acquired immunity, Several strains of the avian leukosis complex are being used in inoculation experiments. Other aspects of the problem that will need to be studied include management, nutritional and physiological factors.

Respiratory Diseases of Chickens and Turkeys

Hall discusses a group of diseases that cause heavy losses in flocks throughout the country, especially in winter, when replacement is costly.

Infectious laryngotracheitis, a virus disease, comes on suddenly and in an acute form may be fatal in loss than a week; a less virulent attack may last 3 weeks. Mortality may be as high as 70 per cent and

the disease also causes a marked drop in egg production. The outstanding symptoms are gasping and coughing, caused by the collection of mucus, pus and blood in the respiratory passages. Diagnosis is not easy because of possible confusion with other respiratory diseases; a labouratory diagnostic test may be necessary. A bird that recovers naturally from the disease becomes a carrier for life and these carriers are the principal spreaders of the virus. Strict sanitation and vaccination are the best preventives. The vaccine is applied to the mucous membrane of the cloaca by scarifying with a stiff bristle brush. Immunity lasts for the life of the bird. Hall says that vaccination should not be practiced if the disease does not exist in the neighbourhood and there is little or no chance that the flock will be exposed to it.

Infectious bronchitis, probably also caused by a virus, is primarily a disease of young chicks. Mortality ranges from 10 to 90 percent. As in laryngotracheitis, diagnosis is difficult and labouratory tests may be necessary. Vaccination is not practicable because the virus in the vaccine reaches tne lungs before immunity is established. The best preventives are careful inspection of purchased chicks, good management of brooder houses, thorough disinfection after an outbreak of the disease.

Infectious fowl coryza (coryza is the medical term for a cold) is an acute inflammatory contagious disease primarily affecting the upper air passages, sinuses and eye membranes. It occurs in two types, a very rapid one, caused by a germ and a slower one, of which the cause is not definitely known. (Fowl cholera can also cause a coryza.) The first symptom is a watery discharge from the nasal passages and often the eyes; later symptoms may be severe. A bacteriological examination and labouratory tests may be necessary for a definite diagnosis. Just how the disease spreads is not known. Preventives include careful attention to housing conditions and nutrition; in California, where "colds" occur annually among pullets, disposal or segregation of old stock before pullets are brought in is recommended. Recently it has been found that sulphathiazole is effective in the treatment of the germ-produced, acute type of coryza.

Non-infectious coryzas may also be caused by a vitamin A deficiency (nutritional roup) and by mechanical irritation. The former is cured by adding supplements rich in vitamin A to the diet.

Sinusitis in turkeys, also called roup and swellhead, is a coryza characterized by swelling of the sinuses in front of the eyes. It may be infectious (cause unknown) or nutritional. The infectious type may be treated successfully by injections of argyrol or silver nitrate according to procedures described by Hall. The nutritional type may be prevented by furnishing an adequate amount of vitamin A in the diet.

Fowl Pox (Diphtheria)

It used to be thought, says Bunyea, that fowl pox and avian diphtheria were two separate diseases. Now it is known that they are different manifestations of a single disease, caused by a virus. In the pox form; characterized by the formation of blisters and later scabs on the skin–usually are unfeathered parts–the disease is generally mild. The diphtheritic form, in which cheesy patches appear on the mucous membranes of the mouth, air passages and eyes, interfering with breathing and eating, may be fatal. Recovery from the disease confers a prolonged immunity. The virus enters the body through scratches or wounds in the skin or mucous membranes and dried material from diseased birds remains infectious for a long time.

There are two types or strains of the virus. One produces the symptoms in pigeons; the other affects all other fowl. Pigeons are relatively resistant to the fowl type and other fowl to the pigeon type.

Poultry can be successfully vaccinated against fowl pox with vaccines prepared from either type of virus. The usual procedure is to apply the vaccine with a stiff bristle brush to feather follicles on a prepared area of skin, or to stab it into the skin with needles; if pigeon pox vaccine is used for chickens, 12 to 20 feather follicles are inoculated instead of only a few, as when fowl pox vaccine is used. The vaccine, which was formerly prepared from pox scabs, is now prepared from virus propagated on developing chick embryos. Vaccination of healthy birds after an outbreak occurs is worth while only if the disease is in a mild form and if the vaccinating is done early, in the outbreak.

There is no known cure for fowl pox and if an outbreak is severe or has been prolonged, it is best to slaughter affected birds. If they

are exceptionally valuable, they may be kept under quarantine to await possible recovery. In any event, as soon as the disease appears, the affected and the healthy birds should be separated and strict sanitary measures, including disinfection of quarters from which diseased birds are removed, should be put into effect. Poultry keepers should be on their guard against introduction of the disease into pox-free flocks or areas.

Psittacosis

The striking new development disclosed by Meyer is that a case of psittacosis (so-called parrot fever) in a human being has apparently been traced to chickens and 10 other cases have been traced to pigeons.

Psittacosis was first discovered as a disease of birds of the parrot family and occasionally of other cage birds such as canaries and finches. The fact that it causes a peculiar type of pneumonia in human beings, reputed to be fatal in 20 percent of the cases, has been known for a long time; but human psittacosis was a medical curiosity until over 750 cases occurred in 1929-30 and 600 more were recorded in subsequent years. As a result, embargoes on imported birds and other restrictive measures were put into effect in the United States. Some States maintain a permanent quarantine against birds of the parrot family. In an effort to stamp out the disease, California has instituted a system, described by Meyer, requiring testing of parrakeets in commercial a viaries and certification of the aviary.

Psittacosis is caused by a virus and is highly infective; it can be spread, for instance, by particles of dust floating in the air. It can now be diagnosed by a blood test and also by an inoculation test with mice, which are very susceptible. These methods have been extremely useful in detecting carriers–apparently healthy birds that harbour and disseminate the virus.

A few years ago it was proved by experiment that chickens are susceptible to the disease. Subsequently, a fatal case of human psittacosis was traced to a sick pigeon; then 9 other cases were traced to pigeons; and finally tests made to pigeon flocks in 5 States showed a surprisingly high percentage of positive reactions. The most recent discovery, already noted, was the isolation of the virus from 2 chickens on a poultry farm in the course of an investigation of a

human case of the disease. It has also been isolated from 25 individual pigeons.

How widespread is the infection among birds on farms? How do they acquire it? What is the risk to human beings? These, as Meyer points out, are among the pressing questions posed by the new discoveries.

Miscellaneous Diseases of Poultry

Bunyea covers a number of diseases, most of which are not discussed elsewhere in the section devoted to poultry.

Paratyphoid infection, caused by organisms of the *Salmonella* group, occurs mainly in young birds, may be either acute or chronic and has various symptoms. It is difficult to control; sanitation in hatching and rearing the young is of first importance. Both infected duck eggs and the flesh of infected squabs may cause food poisoning in human beings, but possible danger from this source is eliminated if these products are thoroughly cooked.

Fowl typhoid, like fowl cholera, is caused by bacteria that live in the blood stream. No remedy or vaccine is available; sanitary measures are important in preventing the disease. The blood test for pullorum disease also detects typhoid carriers. Fowl typhoid is detecting among chickens, increasing among turkeys.

Fowl cholera, characterized by intestinal disturbances, depression and mortality, may be either acute or chronic. Fortunately the bacteria are easily destroyed by sanitary measures. A rapid wholeblood test for the diagnosis of fowl cholera carriers is a recent development. Although not yet widely used, it is a possible aid in detecting the birds that are harbouring the infection.

Mycosis includes three types of disease due to different fungi:

(1) Thrush is due to the presence of fungi in the digestive tract. It produces a discharge from the mouth, loss of appetite, weakness, emaciation and diarrhoea and is frequently fatal. Thorough sanitation is the best preventive, but Bunyea also describes a simple medicinal treatment.

(2) Aspergillosis is caused by fungi in the air passages. It produces gasping, unthriftiness and emaciation and may easily be confused with other respiratory diseases. In young chicks it is rapidly fatal. Strict sanitation is the only known preventive. Sick birds should be segregated or destroyed.

(3) Favus (white comb, avian mycotic dermatitis) is caused by a fungus that attacks the skill. Growths or crusts appear on the unfeathered head parts; elsewhere feathers break off. The disease is said to infect human beings. Treatment with petroleum jelly and formalin, as described by Bunyea, is reported to be very effective.

Infectious avian encephalomyelitis (epidemic tremor), an inflammation of the central nervous system, is spread by direct contact and may be passed on through the egg. A large percentage of a flock may be affected. Although spontaneous recoveries occur, it is recommended that infected birds be quickly fattened and marketed to eliminate carriers.

Avian tuberculosis is discussed in the general article on tuberculosis in this volume. A few additional points are given by Bunyea.

Poisoning of poultry may be due to various causes:

(1) Botulism (limber-neck) is caused by eating feed or other products contaminated with the botulinus organism and its toxins. The condition is likely to be rapidly fatal. Exposed birds may be drenched with Epsom salts and given antitoxin injections.

(2) Common sources of chemical poisoning of poultry include rat poisons, vegetation sprayed with arsenicals, fish brine, ice-cream salt, spent fireworks, poisoned grasshoppers and grasshopper bait and certain worm medicines.

(3) Even small numbers of the insects known as rose chafers will poison young chickens.

Lameness may also be due to anyone of various causes:

(1) Wire cloth with a large mesh may catch the feet or legs of chicks.

(2) Toes and feet may be frozen in cold weather if the birds are not kept in properly arranged houses.

(3) Bumblefoot, a swelling characterized by an accumulation of cheesy material, is probably due to infection of wounds.

It causes great suffering and should be treated by minor surgery, disinfection and bandaging.

(4) Sod disease is an inflammation of the skin accompanied by small swellings filled with fluid. It may affect the feet and the eyelids and is often fatal. The cause is unknown, but birds should be excluded from unplowed prairie land.

(5) Nutritional deficiencies, discussed elsewhere in this volume, may cause lameness.

(6) Fowl paralysis, also discussed elsewhere, is manifested in lameness. Avian tuberculosis, paratyphoid infection and fowl cholera may all cause lameness. Infection with one of the staphylococcus organisms is responsible for a lameness in the feet, legs or wings that often ends in death.

(7) Scaly leg, discussed in the article on poultry mites, is a condition caused by a parasitic itch mite.

"It is normal for a fowl to be in good condition if it is given a chance," says Bunyea. He discusses some of the practices that give the birds such a chance, among them:

(1) Proper location of the poultry house.

(2) Clean, comfortable, well-ventilated houses; abundant, nourishing feed; clean water.

(3) Proper management of brooder houses.

(4) Frequent moving of houses or shelters for growing birds on the range to keep the birds off polluted ground.

(5) Cleaned, disinfected, dry laying houses ready for the birds when they come off the range.

(6) Separate houses for pullets and old hens and for birds of different species.

(7) Mesh wire, or preferably fly screening, on doors and windows.

(8) Exclusion of all visitors from the poultry houses; provision of clean overshoes for those admitted; disinfection of the soles of footwear when entering the poultry house if certain diseases are prevalent in the area.

(9) Quarantining of newly purchased birds or those that have returned from contests or shows.

(10) Prompt action in cases of infectious diseases, including destruction or segregation of sick birds and disinfection of premises.

Internal Parasites of Poultry

Chickens are kept on 85 percent of the farms of the United States, which makes it all the more striking that almost a fifth of the birds are lost every year because of disease. The annual financial loss has been estimated at 180 million dollars, a good deal of it waste because it is preventable.

Wehr and Christensen describe the practices necessary to reduce the part of this loss that is due to internal parasites. These practices depend chiefly on three simple facts:

(1) Most, though not all, poultry parasites are eliminated in the droppings of the birds.

(2) In the crowded poultry communities of today, the surroundings quickly become contaminated.

(3) Birds pick up parasites from these contaminated surroundings–feed, water, soil and infected intermediate hosts such as snails and slugs.

The great preventive, then, is to have clean surroundings. This means, for example, carefully selecting the site for the poultry house; using a type of house that can easily be kept clean; not crowding the birds in runs or yards that cannot be kept clean–instead, either using a series of runs that can be rotated, or confining the birds entirely within the house except perhaps for a "porch" with a wire floor or a small fenced yard covered with cinders or other porous material; disposing of manure promptly and storing it properly; keeping different types of poultry, such as turkeys and chickens or turkeys and pigeons, entirely separate, since a disease that is mild for one type may be disastrous for another and being careful not to spread infection on shoes or clothing. Following these general principles of good hygiene and at the same time feeding the birds well will go a long way toward preventing trouble with parasites.

If an outbreak of parasitism occurs, the healthy birds and the diseased birds should be promptly separated and kept separate and a strict sanitation programme should be carried out. If no local veterinarian is available to make a diagnosis and advise on

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If an outbreak of parasitism occurs, the healthy birds and the diseased birds should be promptly separated and kept separate and a strict sanitation programme should be carried out. If no local veterinarian is available to make a diagnosis and advise on

treatment, the State Agricultural Experiment Station should be consulted as to the advisability of sending birds to the labouratory for diagnosis.

There is little in the way of medicinal treatment for most poultry parasites, the authors point out, through anthelmintics, or worm medicines, are effective for the gapeworm, the large roundworm and the cecum worm; and trichomoniasis of the lower digestive tract of turkeys can be successfully treated by heat therapy–closing the birds for certain periods of time in a box heated to a certain temperature.

After discussing these practical control measures, the authors deal in considerable detail with the principal poultry parasites.

With the exception of coccidiosis, discussed elsewhere in this volume, the diseases produced by protozoa are important mainly in turkeys.

A severe catarrhal inflammation of the intestines of turkeys, caused by a protozoan called *Hexamita meleagridis*, is becoming increasingly important in the United States. The mortality in acute outbreaks runs from 20 to 90 percent and most birds that recover from an acute attack remain stunted. Adult turkeys are the primary source of infection.

Histomoniasis, or so-called blackhead (the head does not always; turn dark), is an acute, highly fatal disease caused by infection with *Histomonas meleagridis*. Until methods of preventing it, based on sanitation, were found, this disease made turkey raising impossible in many parts of the country. Chickens, which are not seriously affected by histomoniasis, become carriers; so do the few turkeys that recover.

A malaria like disease of young turkey poults and ducklings is caused by organisms of the genus *Leucocytozoon*, which attack the blood cells. The disease strikes suddenly in young birds and runs a brief, acute course, with a mortality up to 50 percent in turkeys and 100 percent in ducklings. The causative organisms are transmitted by blackflies.

Two species of trichomonads cause intestinal disturbances in young turkeys, one attacking the crop and gullet the other the cecum and liver. Occasionally, though not usually, the mortality from trichomoniasis of the upper digestive tract is high. The disease in

the lower digestive tract may be confused with histomoniasis and often takes an insidious, slow course, ending in death.

A considerable number of worm parasites of the general types that attack other animals, are found in poultry.

At least three species of flukes, or trematodes, parasitize poultry, but none are of great economic importance. One occurs in the skin of domestic and wild birds, producing hard, cystlike structures, usually in the region of the vent. Another, found in muskrats and water birds, may be responsible for an inflammation of the proventriculus, or true stomach, in chickens. A third is located in the reproductive organs and can greatly reduce or completely stop egg production in laying hens, as well as causing extreme emaciation and anemia. Snails and dragonflies are the intermediate hosts of this fluke.

Several species of tapeworms (cestodes) inhabit the small intestines of fowl; all pass through certain stages of development, when they are known as bladder worms, in intermediate hosts, including houseflies, snails, slugs, ants, earthworms, beetles grasshoppers and sandhoppers. Fowl become infected by swallowing the intermediate hosts.

Roundworms, or nematodes, which parasitize almost every organ in the body of birds, include three groups–those that are transmitted directly, those that are transmitted through intermediate hosts such as various insects and those that are transmitted in both ways. Among the nematodes are the crop worms, the stomach worms, the gizzard worms, the large intestinal roundworms, the small intestinal roundworms, the eye worm and gapeworms, which infest the windpipe and cause the condition known as gapes. The nematodes cause more or less severe illness and sometimes death, depending on the severity of the infestation. In the case of *Ascaridia galli*, one of the large intestinal roundworms, it has been shown that foods high in vitamin A and in the B vitamins increase resistance and that a lack of the vitamin B complex definitely favors parasitism.

Coccidiosis of the Chicken

Coccidiosis occurs in all domesticated fowl and in cattle, sheep, goats, pigs and dogs, but, as Christensen and Allen point out, it probably causes heavier economic losses among chickens than among all the rest combined.

The life history of the common coccidia of poultry goes like this:

(1) The egg like, resistant oöcysts are discharged in the birds' droppings.

(2) Each oöcyst divides into four elongated bodies and each of these into two sporozoites.

(3) An oöcyst thus divided (sporulated) is swallowed by a chicken.

(4) The eight sporozoites are released in the intestinal canal and penetrate cells in the membrane tissue.

(5) After growth, each divides into many merozoites, which parasitize other cells.

(6) Again growth and division occur.

(7) Finally, some of the merozoites develop into males and females and mate.

(8) The fertilized females secrete a resistant shell, becoming oöcysts and are discharged in the droppings.

Coccidia may become localized in the cecum, causing an acute, often highly fatal disease, mostly of chicks 3 to 5 weeks old, characterized by severe cecal hemorrhage; or they may become localized mainly in the small intestine, causing a serious, prolonged disease of older birds characterized by extreme emaciation. The first disease is caused by *Eimeria tenella*, the second by any one of at least six species of coccidia, of which *Eimeria necatrix* produces the most severe symptoms.

In addition to the deaths caused by coccidiosis, many of the birds that recover are permanently unthrifty, as well as being carriers of the infection.

Control of the disease consists in strict isolation .of young birds from adult fowl and in extremely careful sanitation, including such measures as thorough, regular, frequent cleaning of brooder houses with soap and hot water; daily cleaning of chick cages; frequent cleaning of feeding and watering equipment; occasional transfer of movable brooder houses to new ground; careful locating of permanent brooder houses and provision of sloping concrete runs; the same kind of cleaning of laying houses as of brooder houses; provision of clean ground for each group of pullets.

In case of an outbreak, medication does little good, but losses can be minimized by meticulous attention to every detail of good feeding and care.

Poultry Lice and their Control

All the lice that attack poultry, says Bishopp, are of the biting and chewing rather than the bloodsucking type. They cause heavy indirect losses, probably chiefly among farm and backyard flocks. The specialized poultry keeper usually does not permit them to get a foothold and there is no reason why they should not be controlled even in the smallest flock.

All lice live continuously on the host and soon die if removed, but different kinds attack different parts of the body.

The head louse is usually found on the top and back of the head and beneath the bill. Among lice, it is the chief pest of young chickens and turkeys, sometimes causing death before the birds are a month old. The body louse of chickens stays on the skin, usually where the body is not densely feathered and is the most important of the lice attacking adult birds. The shaft louse rests on the shafts of the feathers and apparently feeds only on feathers. Four other fairly common chicken lice are the wing louse, the fluff louse, the large chicken louse and the brown chicken louse.

Turkeys are subject to the attacks of the slender turkey louse and the large turkey louse, as well as of chicken lice. Geese and ducks are seldom noticeably affected by lice, but there are six species that attack pigeons, sometimes damaging the feathers of show birds and perhaps adversely affecting the speed and endurance of carriers.

In general it is best to delouse the poultry flock in the fall so that they will be free of these pests through the following spring. Treatment with sodium fluoride is very effective and practical. Each bird may be thoroughly dusted (most expensive method); or the insecticide may be applied in small pinches to several designated parts of the body; or the birds may be dipped in a solution containing 1 table-spoonful of sodium fluoride to each gallon of water (least expensive method). Sodium fluoride irritates the air passages when breathed in and is a poison when taken internally and Bishopp outlines the necessary precautions in handling it. Sodium fluosilicate may also

be used as a dip. Other treatments, not so effective, are the use of fine sulfur as a dust and the painting of roosts with nicotine sulfate.

Poultry Mites

A large percentage of poultry of all kinds, according to Bishopp, are constantly infested with mites which lower the vitality of the birds, reduce their egg production and in some cases actually cause death.

The common chicken mite is what Bishopp calls a night raider, generally hiding in cracks and crevices during the day. It attacks all parts of the body and feeds by sucking blood and it will attack other animals and human beings as well as poultry. Heavily infested setting hens have been known to die on the nest. To get rid of these mites, remove all boards, boxes and trash that might serve as hiding places; burn the litter and nesting material; spray the poultry house thoroughly with one of the carbolineums, crude petroleum, or creosote oil. One treatment is usually enough.

The feather mite, which remains constantly on the birds, requires a different treatment. Each bird should be dipped in a sulfur bath (2 ounces of fine sulfur and 1 ounce of soap to a gallon of water) on a warm, sunny day or in a heated building; or the birds may be thoroughly dusted with sulfur; or nicotine sulfate may be applied to the perches. The house should also be disinfected as for the common chicken mite.

The scaly-leg mite attacks the shanks and feet and sometimes the comb, wattles and neck. The legs of infested birds may be dipped in crude petroleum. Painting the roosts and nests with a carbolineum also helps to control this mite.

The depluming mite burrows in the skin near the base of the feathers. It may be completely eliminated by dipping each bird in the sulfur bath already described.

Chiggers, the young of the small red harvest mite, attack chickens as well as other animals and human beings. They inject an irritating poison into the skin, to which they attach themselves (they do not burrow in as is commonly supposed). Severe infestations can have a very serious effect on young chickens and turkeys; hence in chigger areas it is best to hatch early or keep. the chicks from late hatches out

of grass and weeds. Dusting the birds and the ranges with sulfur is helpful.

The Fowl Tick

The fowl tick, or blue bug, is a serious handicap to poultry raising in the Southwest, Bishopp points out and it now also occurs in Florida. Its attacks weaken the birds and cause a tick paralysis; egg production is reduced and not in frequently the birds die.

The tick, a flat, oval, leathery-skinned creature, resists many insecticides and can live for more than 3 years without food. It feeds exclusively on blood, preferring birds but also occasionally attacking domestic animals and human beings. Active at night, when the birds are on the roosts, it hides by day in cracks and crevices and is often shipped around the country concealed in poultry crates and other objects. In heavy infestations it may spread from poultry houses to barns and other buildings.

The tick can be controlled by thorough spraying of the building with one of the carbolineums; crude petroleum and creosote oil are less satisfactory. A second application 20 or 30 days after the first may be necessary and sometimes even a third. Bishopp gives directions for the spraying job. He also tells briefly how to construct roosts and nests to make control of the tick comparatively easy.

The fowl tick can be prevented from getting a foothold by such measures as proper choosing of a site and proper construction of a poultry house, buying chicks from tick-free hatcheries, thoroughly spraying used crates and isolating, for a period of 10 days, any fowl brought to the place.

Bedbugs as Pests of Poultry

Bedbugs are common pests of poultry as well as of human beings and domestic animals; in fact, as Back and Bishopp point out, they can easily be carried from poultry houses, where they hide in cracks and holes, to human dwellings. Wooden poultry crates are often heavily infested. The bugs feed mostly at night or in subdued light, take about two days to digest a full meal and can go without food for as long as 2 months. When they are abundant, they suck so much blood that chickens do not fatten and setting hens may die and the effects are especially disastrous in the case of squabs. The Mexican chicken bug (coruco, adobe bug), an important pest of poultry in the Southwest, is very much like the bedbug.

Keeping these insects under control requires vigilance and persistent effort. Hiding places should be eliminated as far as possible by simple construction, the removal of stray boards and trash and where it is practicable, the filling of cracks. Fumigants, such as burning sulfur, are effective in killing the bugs if the poultry house is tight enough (but few are). Thorough spraying with creosote oil or a carbolineum is satisfactory and so are kerosene and pyrethrum-kerosene fly sprays. In feeding establishments, it is well to spray crates once a month. In pigeon lofts, spraying the nests if not properly done may have a bad effect on eggs and squabs; treating the lofts with live steam has been effective under some circumstances.

The Pigeon Fly

A little smaller than a housefly and very active, the pigeon fly is a parasite only of pigeons and their close relatives. Bishopp describes how the insect crawls rapidly about among the feathers and sucks blood from both adult birds and squabs. In addition to causing irritation and loss of blood, it carries the pigeon malaria organism. It also bites human beings.

The fly lays neither eggs nor larvae, but pupae already formed, from which adult flies emerge, usually in about a month or less. These egg-shaped pupae tend to drop to the bottom of the nest boxes. The simplest way to control the pest, then, is to clean the nests and floors thoroughly every 25 days. The trash should be burned, or stored in a screened manure pit or bin equipped with a fly trap, or promptly spread and plowed under. Thorough soaking with a high-grade pyrethrum-kerosene spray will also kill the pupae

Adult flies on squabs can be killed by applying two or three pinches of pyrethrum, derris, or cube powder. Kerosene extract of pyrethrum kills the flies on adult birds or squabs and also in handling and killing rooms. When used on the birds, it should be applied with great care.

Once a loft has been freed of pigeon flies, Bishopp emphasizes, it should be kept free.

Nutritional Diseases of Poultry

Before discussing a considerable number of nutritional diseases of poultry, Titus points out that knowledge in this field is in a state of active change.

Vitamin A

Perhaps the primary function of vitamin A is the nourishment and repair of the epithelial structures (skin and internal membranes), which are the body's first line of defense against infection. It is also necessary for the normal functioning of the eye. In severe cases of deficiency, practically every organ of the body is affected. There are degenerative changes in the nerves and the eyes are inflamed. A partial deficiency in the diet of chickens, especially after dry weather has damaged green for age, is more common than is ordinarily supposed. Titus gives the amounts of vitamin A needed by chicks, turkey poults, chickens kept, for egg production and breeding stock and also, the amounts contained in the richer sources of this vitamin used in feeding.

Vitamin B_1

According to present evidence, vitamin B_1 is necessary for the proper metabolism of carbohydrates; in its absence, pyruvic acid, an intermediate product of this metabolism, accumulates and has a toxic effect on the nervous system. A deficiency does not occur in ordinary poultry production but can be produced experimentally. Typical symptoms of the experimentally produced disease in chickens are a decrease in appetite, a loss of weight, general paralysis and a peculiar raising and drawing back of the head. There is no evidence of an actual degeneration of the nerves such as was attributed to vitamin B_1 deficiency by earlier workers

Vitamin B_6

Little is known about the requirements of poultry for this vitamin or the symptoms of a deficiency, which infact does not occur under ordinary conditions.

Vitamin D

This vitamin is required for the normal metabolism of calcium and phosphorus in the chicken. A deficiency in the diet of growing chickens produces the abnormal condition of the bones known as rickets; in the adult chicken it causes a thinning of the egg shells and, in severe cases a decrease in egg production and hatchability. Various other conditions can cause abnormal bone development (rickets or osteoporosis), but vitamin D deficiency is the most common cause in poultry. As Titus points out, it was impossible to raise

poultry in strict confinement, without access to sunshine, before the importance of vitamin D in their nutrition was discovered. Now some vitamin D is commonly included in the diet whether the birds have access to sunshine or not. The usual sources are cod-liver oil, sardine oil, certain other fish oils and D-activated animal sterol. Titus gives the amounts of the vitamin required, as well as the amounts contained in various commonly used sources.

Vitamin E

Crazy chick disease (nutritional encephalomalacia), which is usually characterized by extensive tissue changes in the brain, has been produced in chicks, ducklings and poults by feeding a diet high in fat but very low in vitamin E. It occasionally occurs in commercial flocks, perhaps through destruction or inactivation of vitamin E in feed kept too long. Titus recommends feeding mixtures while they are fresh and avoiding excessive quantities of cod-liver oil or other fats and oils in the diet. The disease can be checked in a flock and some cases can be cured, by feeding 1 percent of the oil extracted from corn, soyabeans, peanuts, wheat germ, or cottonseed. Another condition produced experimentally by Vitamin E deficiency is nutritional myopathy, a disease involving the skeletal muscles in ducklings and the muscles of the gizzard in poults.

Vitamin G

This vitamin plays a basic role in cell processes, and available evidence indicates that the growing chick requires it for the normal functioning and maintenance of the nervous system. A partial deficiency in chicks results in a condition known as curled toe paralysis as well as other symptoms, including marked adverse effects on growth; in turkey poults, a skin inflammation occurs. Since relatively few feedstuffs contain enough vitamin G to meet minimum needs during the first few weeks of life, it should be provided by careful selection of feeds. Titus gives requirements and the amounts contained in various rich sources.

Vitamin K

Apparently, vitamin K is needed for the formation of prothrombin, which in turn is necessary for the normal clotting of blood. Hemorrhages occur in very young chicks fed an experimental diet deficient in the vitamin. No deficiency is likely to occur under ordinary conditions.

Pantothenic Acid

Observations indicate that this vitamin or vitamin like factor is necessary for the maintenance of a normal spinal cord in the growing chick. A deficient diet fed experimentally produces, among other symptoms, a characteristic skin condition around the corners of the mouth and on the soles of the feet. Possibly some skin conditions seen in poultry flocks are due to a deficiency of pantothenic acid, such as might occur with certain diets. Titus gives the requirements tentatively set and the amounts in some of the rich sources. He also describes a condition called egg-white injury which closely resembles pantothenic acid deficiency but appears to be due to a deficiency of biotin (vitamin H).

Manganese and Choline

It is now known that manganese and choline (a substance found in most animal and plant tissues) somehow have a combined action in the development of a normal skeleton. Choline is seldom deficient in poultry diets; manganese, however, can easily be deficient unless the birds have access to the natural source, the soil. A deficiency of manganese (or choline, or both) in the diet of chicks, poults and ducklings produces perosis, also called hock disease and sliped tendon, characterized, among other symptoms, by enlarged joints and bending of the shank and drumstick bones. In mature birds, eggshells tend to become thin; in severe cases egg production is reduced, embryonic mortality is high and the embryos are abnormal in development. Titus gives directions for including enough manganese sulfate in the diet, mixed with salt, to serve as insurance against perosis.

Iron and Copper

Anemia rarely if ever occurs among chickens under ordinary conditions. It has been produced experimentally by feeding a diet extremely deficient in iron or copper or both, as well as by a deficiency of some unknown nutritional factor. Anemic embryos are sometimes encountered and there is evidence that lack of sunshine, or of cod-liver oil in the diet, reduces the transfer of iron and copper to the eggs.

Iodine

Goiter has been produced experimentally in chickens by feeding a diet low in iodine, and it has been reported to occur in Montana

and Minnesota. It is probably more common in certain parts of the country than is generally realized. Titus suggests that the use of iodized salt for poultry may be a worth-while insurance, at least in areas where goiter occurs in either farm animals.

Gizzard Erosion

A weakening of the gizzard lining occurs commonly in chicks and is of several distinct types, apparently due to different causes. It seems to have no ill effects but probably indicates a somewhat unsatisfactory diet if it continues after the chicks are 4 weeks old. Titus lists several substances reported to be of value in clearing up the condition.

Feather Picking and Cannibalism

Cannibalism in a flock is more serious than feather picking and nearly always leads to heavy losses. Experiments indicate that diets very low in crude fiber content are a likely cause. The use of ruby lights in place of ordinary lights and the feeding of a diet containing 20 percent of barley or oats or 30 percent of bran and middlings are reported to be useful preventives. Titus gives directions for the use of salt to cure birds of these practices and for trimming back the beaks if the salt cure fails to produce results.

Fluorine and Selenium Poisoning

Fluorine poisoning depresses the rate of growth and egg production but does not occur in chickens unless the drinking water contains a certain percentage of fluorine, or unless rock phosphate or phosphatic limestone that contains fluorine is included in the diet. Selenium poisoning has several serious effects. As Titus points out, selenium has been found in the soils and vegetation in at least 11 States and probably occurs in others.

Diseases of Unknown Origin

Titus describes several conditions, encountered for the most part in experimental work, that apparently have dietary causes, not yet definitely determined–an enteritis, or inflammation of the intestines, a paralysis, an arthritis and an associated leg deformity, a dermatosis and fatty degeneration of the liver.

Titus concludes his article with a brief discussion of the influence of nutritional deficiencies on growth and reproduction.