ON THE VALUE OF COLLOIDAL IODINE CHANDLER IN THE CONTROL OF COCCIDIOSIS IN POULTRY AND RABBITS

Thesis for the Degree of M. S.

Ernest Steven Weisner

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THESIS

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Introduction

Coccidiosis of poultry and rabbits is a serious disease, resulting in a high percent of mortality, especially in chicks from three to ten weeks of age (1) and in rabbits at weaning age of about eight weeks (2). It is caused by a protozoan parasite of the order Coccidiida which invades the lining of the digestive tract and the gall ducts of the liver, and is cosmopolitan in distribution.

The coccidia of poultry are described as a single species, Eimeria avium. There are, however, probably three or four races if not distinct species, at least two of which are pathogenic. One of these is parasitic in the caeca and is particularly pathogenic to young chicks, another and smaller race or species is parasitic in the small intestine, especially in the duodenum and is particularly pathogenic to birds of about the broiler age to adults and causes symptoms simulating those described for "range paralysis". Likewise in the case of coccidia of rabbits, only one species, Eimeria stiedae, is described.

(1) Charles, T. B. and Knandal, H. C. - Rearing Chicks in Confinement, Bul. 218, Pennsylvania Exp. Sta.

(2) Meek, M. W. - Extracts from Bul. 496, U.S.D.A., Am. Poul. Advocate, Jan. 1920, p. 128.

There are, however, at least two races if not distinct species, one producing a large oocyst (25.2 x 21.6 microns) and a smaller (12 x 12 microns) one.

The coccidia belong to the class Sporozoa and in common with other sporozoa there are three distinct cycles or divisions to the life history, the schizont or asexual cycle, the gametont or sexual cycle and the sporont cycle.

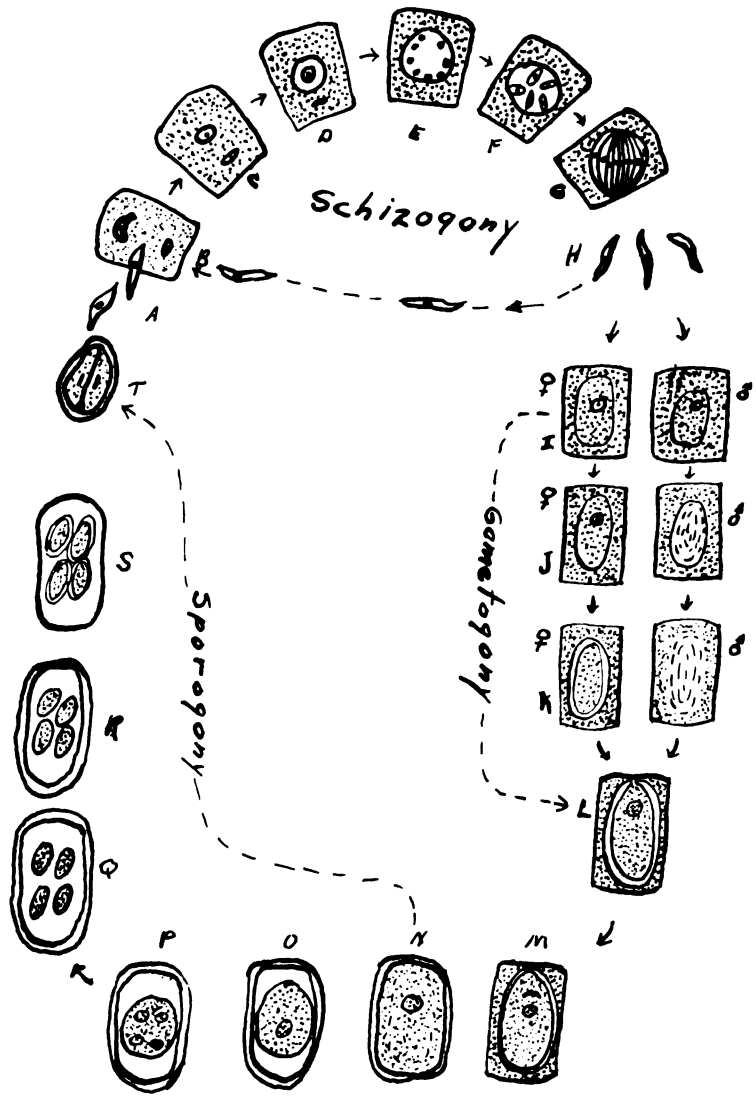
The sporont cycle, the result of sexual reproduction, is apparently the most important division from the standpoint of control since the products of this cycle afford the means of transfer from host to host. These products are called oöcysts and are excreted with the droppings from the infected animals in large numbers. The freshly voided oöcysts as seen under the microscope show a rounding off of the cytoplasm with a clear hyaline appearance to the rest of the cyst. In this stage the oöcysts are non-infective, they must undergo a period of incubation before becoming infective. The length of the incubation period is generally three to four days but may vary, depending on conditions present. The factors influencing the time of incubation are the degree of moisture present, the temperature and the extent of aeration, the presence of available oxygen being a necessary condition to insure incubation. The incubation period is therefore directly proportional to the amount of putrefactive material present which uses up oxygen. The oöcysts when fully incubated contain four sporocysts each

containing two sporozoites and is the infective stage. When taken into the body of the animal the sporozoites are liberated and enter the epithelial cells of the lining of the intestine and develop at the expense of the cells giving rise to numerous small cigar-shaped bodies known as merozoites. The liberation of the merozoites completes the schizont cycle. The liberated merozoites enter other neighboring cells and repeat the cycle.

The asexual or schizont cycle takes place beginning with the establishment of the sporozoites in the cells lining the intestine. How long this cycle may continue and how often the development of merozoites may result is not definitely known. The completion of each schizont cycle may be very rapid however. Young chicks fed incubated oöcysts have died within twenty-four hours with acute coccidiosis and newly formed oöcysts recovered from the intestines.

Eventually the gametont or sexual cycle occurs. In this cycle there develop the male elements within certain cells and the female elements within other epithelial cells. The female element is egg-shaped and constitutes the oöcyst. When fertilized by the union of the male element with the nucleus of the oöcyst the oöcysts are freed from the epithelial cells and are discharged with the droppings (3).

(3) After Brumpt.



Life History of the Genus Eimeria (3).

A - Sporozoite
B - Epithelial cell (Showing
C - " " young
D - " " parasite)
E - Showing schizont
F - Merozoite development
G - Merozoites
H - Liberated merozoites
I - Macro and microgametocytes
J - " " "
K - Macro and microgametocytes
L - Macrogamete
M - Fertilized macrogamete
N - Oöcyst
O - "
P - "
Q - Sporoblasts
R - Sporocysts
S - Sporozoite development
T - Mature sporozoites

(3) After Brumpt.

The degree of infestation is directly proportional to the number of oöcysts ingested by the animal. Each oöcyst carries but eight bodies capable of directly setting up a parasitic condition and being somewhat limited in regard to locomotion the area parasitized by one incubated oöcyst is very minute. The area of infection resulting from the ingestion of one oöcyst being about the size of a small pin head.

The only manner in which this disease may be contracted is by ingestion of incubated oöcysts; the principle source being food or water contaminated with material carrying the oöcysts. Flies and earthworms may also harbor oöcysts and be eaten by fowls. Some investigators claim to have infected chicks with coccidiosis from egg shells immediately following hatching and while very probable my experiments in this regard did not meet with success.

A chick suffering from coccidiosis may show little or no symptoms of disease, death resulting from no apparent cause. In the majority of cases there is evidence of blood in the droppings which may vary from a slight tinge to that of clear blood. The chick appears listless, studip and sleepy. However, the appetite often remains good to the last. The wings may droop and appear partly spread and in the latter stages the bird becomes paralyzed. In the chronic type, found in birds from the broiler age to adults, the symptoms are even more obscure. Often the disease is not

diagnosed or suspected as the cause of the slow death that accompanies this type of coccidiosis. In this type of parasitic infestation the main symptoms are those simulating "range paralysis". There may be a general unthriftiness accompanied with diarrhea, paleness of comb and wattles. The appetite may become ravenous (4).

Upon autopsy of the young chick the caeca or blind pouches are usually enlarged with thickened walls, often discolored. Areas of necrotic tissue are evident associated with distinct inflammatory changes. Evidence of the parasite may be found in but one or both of the caeca. The caecal contents may be reddish in color and firm in consistency, the lining being swollen and spotted showing small hemorrhages. These may be found in some cases on the outer wall of the intestine anterior to the caeca. In the liver the lesions are seen as round yellowish circumscribed areas resembling small specks. A mount from these areas or from the contents of the caeca under the microscope shows numerous oöcysts of the parasite.

In older birds the caeca are seldom involved, the area attacked being the duodenum. In heavy infestations distinct inflammatory changes are seen in the lining of this area accompanied by a thickening of the wall. The inflammatory

(4) Graham, Robert and Tunnicliff, E. A. - Coccidiosis of Poultry, Cir. Bul. No. 288, U. of Ill.

changes are not specific in diagnosing the disease but microscopic mounts made from the contents of the intestine will show large numbers of the causative agent (4).

Coccidiosis in rabbits is similar in its mode of attack. Young rabbits may show no evidence of being diseased and die suddenly. Again a young rabbit may appear unthrifty, having a ruffled coat, its eyes may appear glassy, it may have a prominent abdomen giving the animal a pot-bellied appearance. The appetite is usually ravenous, often the disease is accompanied by a diarrhea, death follows finally, occassionally with convulsions (2).

At autopsy rabbits dying from coccidiosis show necrotic areas in the wall of the digestive tract that are surrounded by inflamed areas. The liver shows the same characteristics as found in birds (2).

Lightly infected rabbits are generally stunted in growth and are slow in reaching maturity (2).

Coccidiosis is a decidedly economic disease of both poultry and rabbits. It is a common occurrence, in heavily infected flocks, to lose from twenty-five to fifty percent of all birds, in exceptionally heavy outbreaks losing the whole number (4). Likewise in rabbits kept under insanitary con-

(4) Graham, Robert and Tunnicliff, E. A. - Coccidiosis of Poultry, Cir. Bul. No. 288, U. of Ill.

(2) Neek, M. W. - Extracts from Bul. 496, U.S.D.A., Am. Poul. Advocate, Jan. 1920, p. 128.

ditions as high as seven out of nine young rabbits are lost.

Coccidiosis in its ravages is aided materially by poor sanitation. Poorly drained runs and filthy quarters favor the growth of the parasite. In rainy weather, owing to the presence of moisture and warmth, the development of the parasite in its incubating period is hastened bringing about a more complete or extensive infestation (4). An absorbent litter used on the floor of the quarters will tend to shorten the time necessary for incubation. Excessive organic matter present may be a factor inhibiting the growth during this period. The products of decay tend to retard the development within the oöcyst.

Owing to the location of the parasite being imbedded as it is in the mucosa and sometimes the submucosa of the intestine, there is little or nothing that can be done in regard to medicinal treatment at least by oral administration. Hence the limiting of the infestation must depend largely on sanitary measures and the periodic destruction of the oöcysts in the animals' quarters. Colloidal iodine (Chandler), however, appears to be the only agent which accomplishes the destruction of the oöcysts. Hence in the experiments here reported colloidal iodine (Chandler) was used for this purpose.

(4) Graham, Robert and Tunnicliff, E. A. - Coccidiosis of Poultry, Cir. Bul. No. 288, U. of Ill.

Experimental Data

The purpose of the following experiments is to determine the sources of infection.

Experiment No. 1.

Thirty chicks were fed fragmented egg shell taken from various trays in a large hatchery for four weeks but failed to develop coccidiosis. Care was exercised to pick egg shells that were smeared with feces.

Experiment No. 2.

Feces from a bird showing coccidiosis were collected. These were allowed to remain standing over night exposed to air at room temperature and then smeared on several eggs. The eggs were kept at room temperature for twenty-four hours and then placed in an incubator at 103°F. After several days in the incubator the eggs were removed and placed in a moist chamber to avoid further drying. The fecal material was scraped from the eggs and fed to a group of chicks. These chicks did not develop coccidiosis.

Another portion of the fecal material used above was placed in a moist chamber and allowed to remain at room temperature for forty-eight hours to incubate the oöcysts. Eggs were then smeared with this material and placed in the incubator. After several days three newly hatched chicks were fed this material but failed to become infested with coccidiosis.

Some of the material used in the previous section of this experiment was taken from the moist chamber after forty-eight hours and placed in 2% potassium dichromate solution for twenty-four hours. Eggs were then smeared and as soon as the material was dried on the eggs they were placed in the incubator. After being in the incubator five days the fragmented shells of these eggs were fed to newly hatched chicks. The chicks did not develop coccidiosis.

Experiment No. 3.

Eleven birds, three weeks of age, that had coccidiosis were placed indoors in a screen bottom cage. The oöcysts soon disappeared from the droppings. An attempt was made to determine if, by lowering the vitality of the birds, the oöcysts would again appear in the droppings. The changing of the feed of these birds to incomplete or poorly balanced rations did not cause a return of the oöcysts. A virulent twenty-four hour culture of Salmonella pullorum was obtained and fed to the birds. Some of the birds were injected with 0.5 cc of this culture but there was no showing of oöcysts. Cultures of Bacterium abortus were fed to the birds with like results. As a last resort cultures of Botulinus in brain media were given the birds in their feed but the oöcysts did not return. The birds were then removed to a poultry house and continued under ordinary conditions. Being exposed to the natural sources of infection the oöcysts soon appeared in the droppings.

Limiting the Continuous Sources of Infection

The oöcysts of this parasite are very resistant to the general classes of disinfectants but are easily destroyed with various dilutions of colloidal iodine (Chandler) (5). Experimental data show that even high dilutions of colloidal iodine (Chandler) solutions destroys washed specimens of the cysts of coccidia. The strength as determined with washed oöcysts obtained from scrapings of the intestines of birds being less than 100 parts of the iodine in one million parts of water. However, for the treatment of surfaces for the destruction of the oöcysts the strength of the preparation should be sufficient to overcome the action of the iodine with the organic matter present and still have sufficient free iodine left to destroy the oöcysts. This strength was determined to be about two-tenths percent in the case of worm eggs and larva and found practical in the case of coccidial oöcysts (5).

Having these data at hand it was thought advisable to conduct a series of experiments for the purpose of collecting field data on the value of colloidal iodine (Chandler) for the destruction of oöcysts on the floors of brooder houses and in rabbit hutches and for limiting the source of continuous infection and observe the results in view of decreasing the degree of infestation already present.

(5) Chandler, Dr. W. L. - Iodine on the Poultry Farm. Reprinted from Poultry Science, Vol. VI, No. 1. Oct. - Nov., 1926.

In the following experiments the rabbit hutches and the brooder houses used were first mechanically cleaned and then treated with a dilute solution of colloidal iodine (Chandler) carrying 0.4% I_2 for the first cleaning, care being exercised to thoroughly cover the entire surface. For successive cleanings a solution carrying 0.2% was used. The reason for the double strength being used in the first treatment is to have sufficient free iodine present after the reaction of the iodine with the alkaline materials remaining from previous applications of lime. After the first cleaning this alkaline material is neutralized and the weaker strength of iodine can be used for subsequent treatments.

The procedure carried out in these experiments was to remove the animals from their quarters and place them in as clean a cage or run as the premises could provide. The litter and droppings were then scraped from the quarters as thoroughly as mechanical cleaning could remove them. After this operation the quarters were scrubbed using hot water and a stiff brush or broom, followed immediately by the treatment with the iodine solution swabbing the iodine into all the crevices and as high on the walls as the object bearing materials might have been lodged. In the experiments on rabbits samples of droppings were taken from the rabbits as they were being removed and mounts were made of this material to determine the effectiveness of the operations.

The results of these operations are evident in the following graphs:

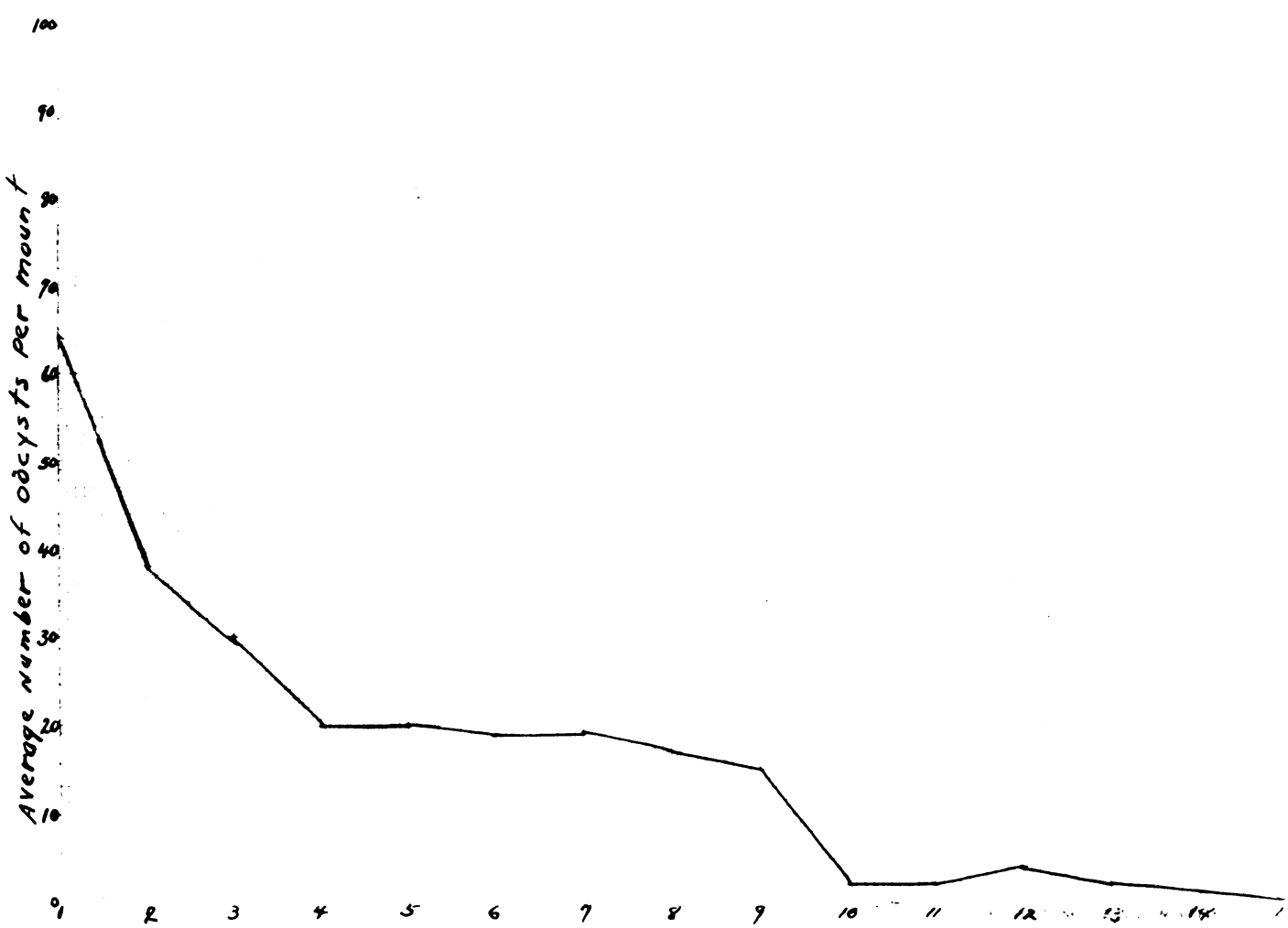
Experiment No. 1

Graph

Showing Decline of

Number of Oöcysts

in Rabbit No. K - 17



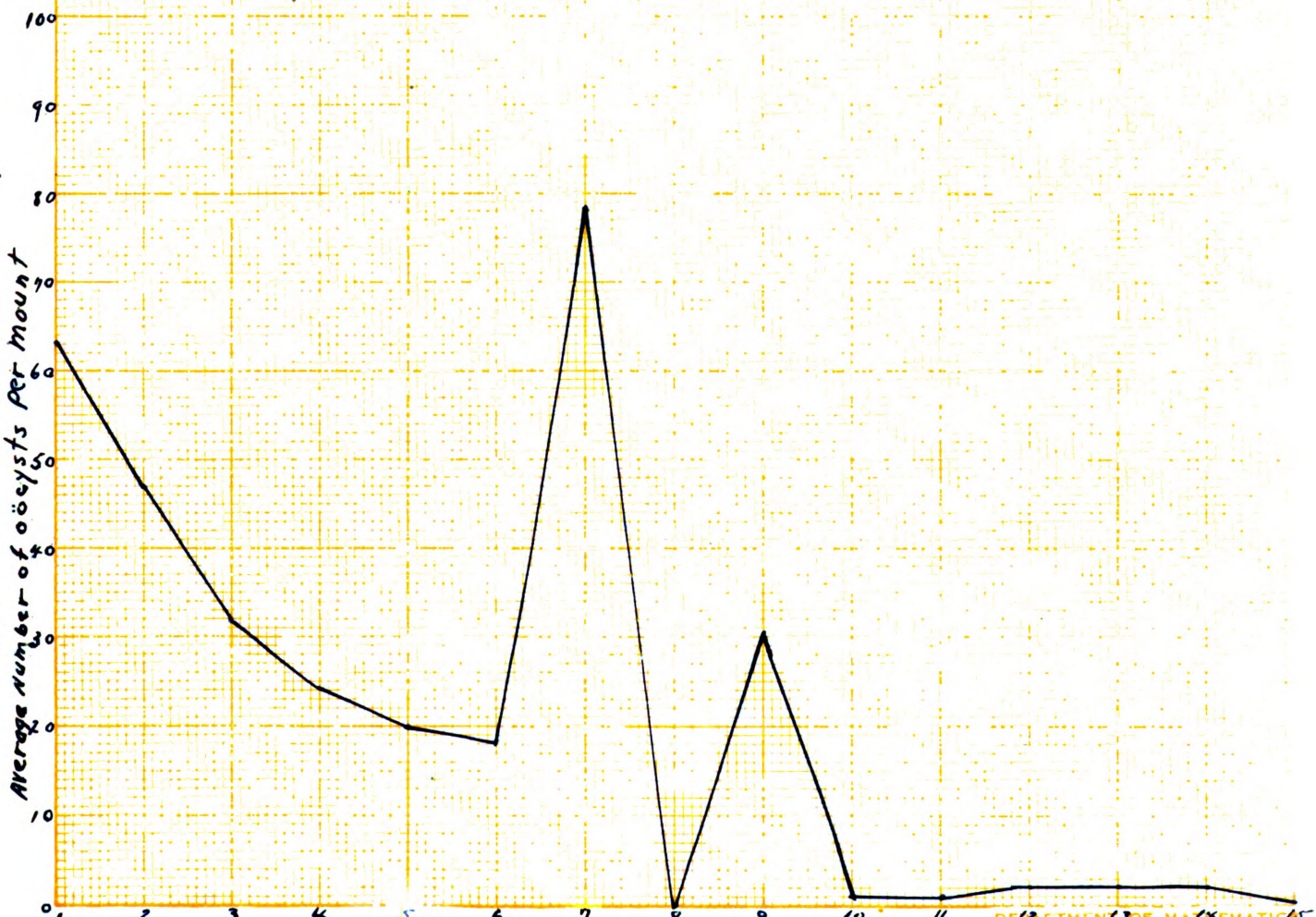
Experiment No. 1

Graph

Showing Decline of

Number of Oöcysts

in Rabbit No. K-18



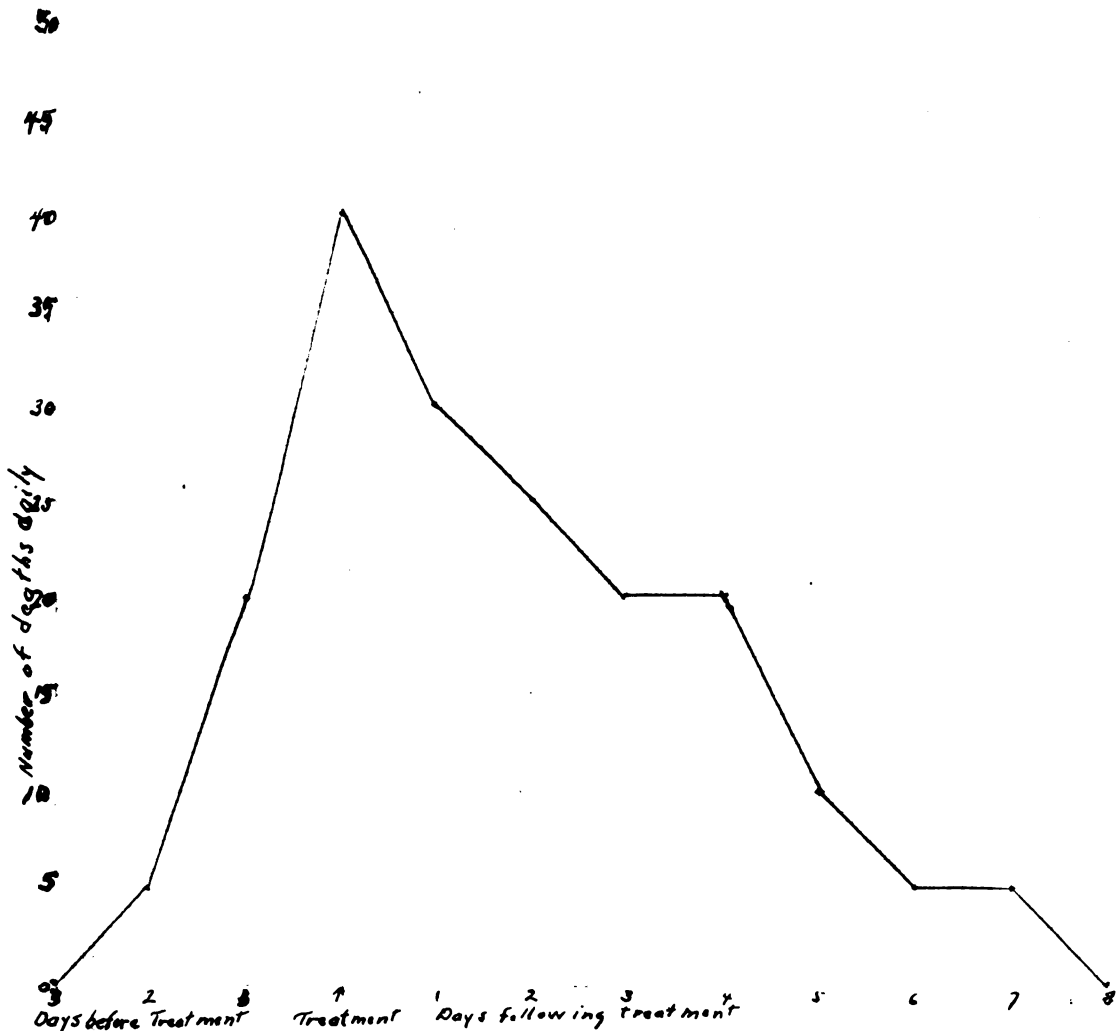
Experiment No. 2

Graph

Showing Result of Sanitary

Measures on Coccidiosis in

1300 Chicks 3 Weeks Old.



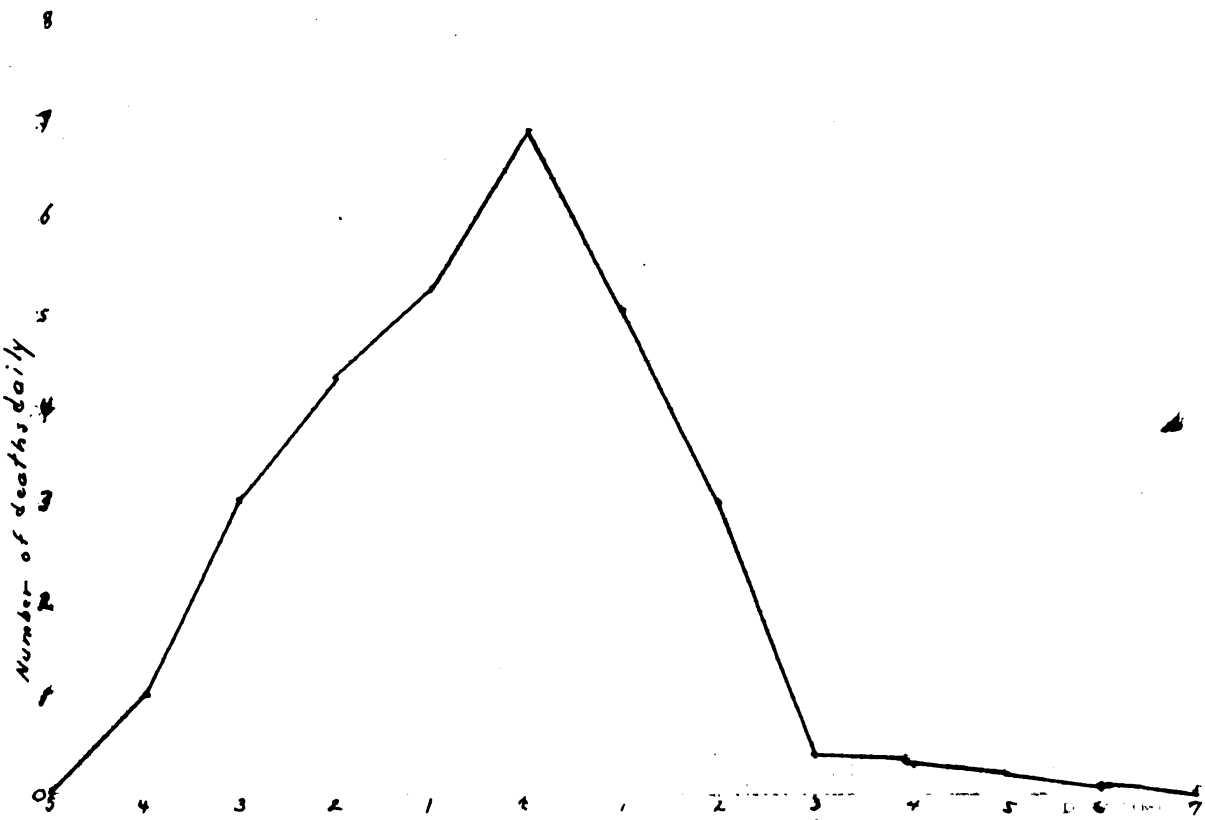
Experiment No. 3

Graph

Showing Results of Sanitary

Measures on Coccidiosis in

150 Chicks 3 Weeks Old



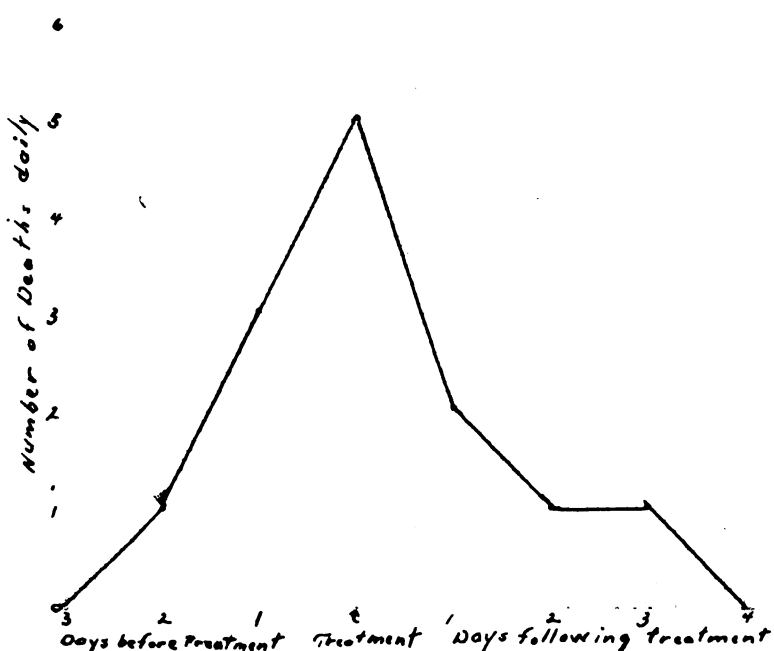
Experiment No. 4

Graph

Showing Results of Sanitary

Measures on Coccidiosis in

350 Chicks 3 Weeks Old



Experiment No. 5

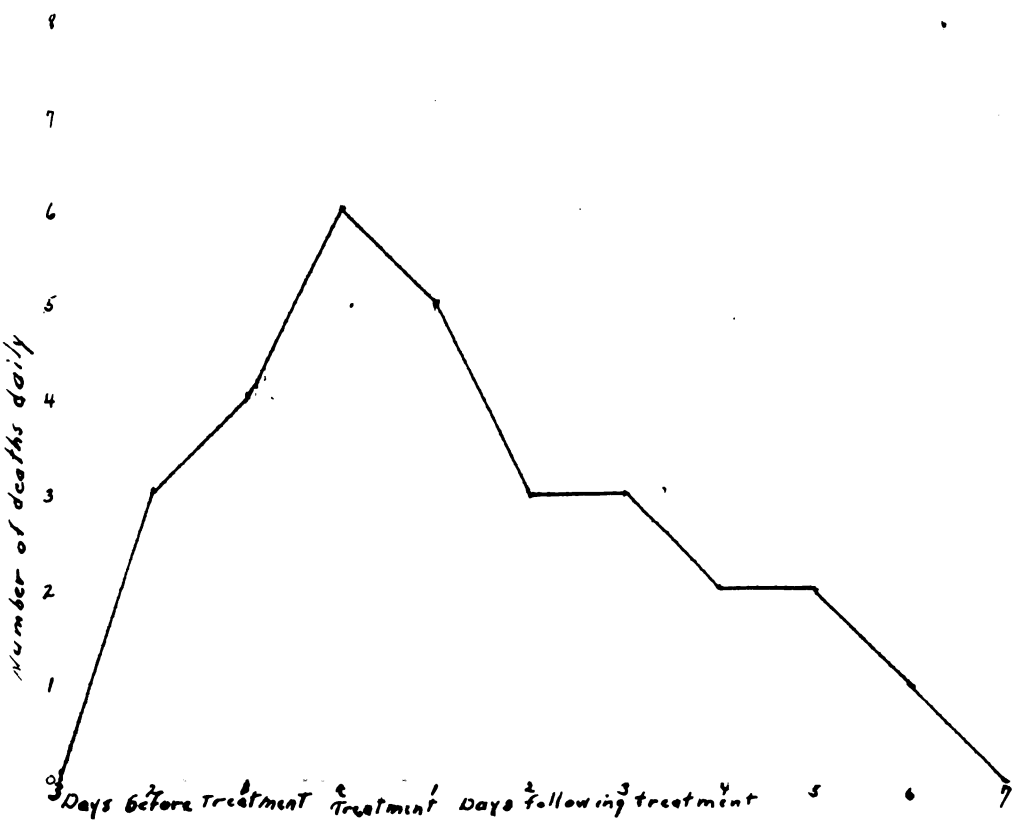
Graph

Showing Results of Sanitary

Measures on Coccidiosis in

200 Chicks

Average Age 3 Weeks



Feeding Colloidal Iodine (Chandler) in Excess of the Birds Normal Iodine Requirements in Order to Assist the Animal in Combatting the Toxins Resulting from the Infection.

The location of the schizont cycle of the parasite in the mucosa and submucosa of the intestine renders the parasite highly impervious to the action of medicinals. Control measures must, therefore, depend, aside from sanitation and the destruction of the oöcysts, on increasing the vitality of the birds through care and feeding. It also appears probable from the following experiment that the feeding of colloidal iodine (Chandler) in excess of the normal iodine requirement may be of value in aiding the bird to overcome the action of the toxins arising as the result of the intestinal parasitism.

A flock of forth birds heavily infested with coccidiosis was divided into two groups of twenty birds each. Each group was placed in colony houses in which no attempts were made to disinfect. Both groups of birds received a like ration except that the birds in group one received an average of five milligrams of iodine in the form of powdered colloidal iodine (Chandler) daily. This procedure was continued for a period of approximately two months after which the birds were weighed and the experiment discontinued. The results of this experiment, as given in the accompanying tables, at least suggest an experiment on a much larger scale.

Pen No. 1 - Twenty birds

Treatment: Powdered Iodine on feed daily-0.005 gm. per bird
Liquid Iodine Dec. 12th

Bird No.	Weight at beginning of test	Weight at end of test	Gain in weight in lbs.	Loss in weight in lbs.	Remarks
80	3.50#	3.50#	0.00	0.00	
79	3.00	3.00	0.00	0.00	
78	3.75	4.50	0.75	0.00	
77	3.25	3.50	0.25	0.00	
76	4.00	4.00	0.00	0.00	
75	2.50	3.00	0.50	0.00	
74	3.00	4.25	1.25	0.00	
73	3.50	3.50	0.00	0.00	
72	3.50	3.50	0.00	0.00	
71	2.75	2.50	0.00	0.25	Moulting
70	2.75	4.25	1.50	0.00	
69	2.50	3.00	0.50	0.00	
68	3.25	3.25	0.00	0.00	
67	3.50	4.00	0.50	0.00	
66	3.00	3.50	0.50	0.00	
65	3.00	3.25	0.25	0.00	
64	3.00	5.00	2.00	0.00	
63	3.25	3.25	0.00	0.00	
62	2.75	2.75	0.00	0.00	
61	3.50	3.25	0.00	0.25	
Total	63.25#	70.75#	8.00	0.50	
Average	3.16	3.54	0.80	0.25	

Average gain per bird - 0.38#
Worms Dec. 12th - 58 roundworms, no tapeworms
Total eggs in 60 days - 230

Pen No. 2 - Twenty birds

Treatment: Controls
Liquid Iodine Dec. 12th

Bird No.	Weight at beginning of test	Weight at end of test	Gain in weight in lbs.	Loss in weight in lbs.	Remarks
60	3.25#	4.00#	0.75	0.00	
59	3.50	4.00	0.50	0.00	
58	3.50	4.00	0.50	0.00	
57	3.00	3.00	0.00	0.00	
56	3.25	3.25	0.00	0.00	
55	2.75	3.00	0.25	0.00	
54	4.00	4.25	0.25	0.00	Evidence Coccidiosis
53	3.00	2.00	0.00	1.00	Chronic Roupe
52	3.25	4.00	0.75	0.00	
51	3.00	3.00	0.00	0.00	Evidence Coccidiosis
50	4.00	4.00	0.00	0.00	
49	2.75	3.00	0.25	0.00	
48	4.25	3.50	0.00	0.75	Evidence Coccidiosis
47	3.50				Died of Coccidiosis
46	3.50	4.00	0.50	0.00	
45	4.25	4.25	0.00	0.00	
44	3.00	3.25	0.25	0.00	
43	3.00	2.00	0.00	1.00	"Range paralysis"
42	3.00	2.00	0.00	1.00	Coccidiosis
41	2.75	2.50	0.00	0.25	Coccidiosis
Total	76.50#	63.00#	4.00	4.00	
Ave.	3.82	3.33	0.45	0.80	

Average loss per bird - 0.51#
Worms Dec. 12th - 85 roundworms, no tapeworms
Total eggs in 60 days - 194

Such an experiment as suggested by the results of the previous experiment is now under way.

Four groups of young chicks, 136 birds in each group, were secured and put in four brooder houses. The birds in house No. 1 will be reared in confinement similar to those grown by Charles and Knandal at Pennsylvania. They will not have access to the ground and the house itself is screened against flies. Before placing the birds in the house all the appliances, as water fountains, feed hoppers and the like, were thoroughly iodized using a solution of colloidal iodine (Chandler) carrying 0.4% I_2. Being kept from the ground and screened from flies the chances of becoming parasitized are reduced to a minimum. The floor of the run is provided with a half inch mesh screen to allow the droppings to fall through.

The birds in house No. 2 will be grown as chicks under average conditions having access to the ground and no effort being made to protect them from becoming infected with internal parasites. The ration, however, includes 20% more powdered buttermilk than that fed the birds in house No. 1. Powdered colloidal iodine (Chandler) will be added to this ration daily, providing approximately 0.005 ~~milli~~grams of iodine for each bird.

The living conditions of the birds in house No. 3 will be similar to those found in house No. 2. The ration fed this group of birds is identical to the ration fed in house No. 2 with the exception of powdered colloidal iodine (Chandler).

House No. 4 is the control group. The ration fed these birds is the same as fed to those in house No. 1.

The ration fed in houses Nos. 1 and 4, and used as a base for the ration used in houses Nos. 2 and 3, is known as the Ohio Ration and consists of: 60 pounds finely ground corn; 20 pounds middlings; 10 pounds powdered buttermilk; 5 pounds meatscrap; 4 pounds bonemeal and 1 pound salt.

The birds will be carried under these conditions until a year following the beginning of production.

Conclusions.

1. The ingestion of incubated oöcysts is the only means whereby animals can become parasitized with coccidia.
2. The degree of infestation is directly proportional to the number of incubated oöcysts ingested by the animal.
3. The principle sources of infestation are through contaminated food and water.
4. The limiting of the infection depends largely on sanitary measures and preventing the ingestion of oöcysts by the periodic destruction of the oöcysts in the animals' quarters.
5. Highly dilute solutions of colloidal iodine (Chandler) easily destroy the infective stage of this parasite.
6. The degree of infestation can be reduced materially by strict sanitary measures and the use of solutions of colloidal iodine (Chandler).
7. The feeding of colloidal iodine (Chandler) in excess of the animals' normal iodine requirement aids the animal in combatting the toxins resulting from the infection.

Acknowledgment

The writer wishes to acknowledge his indebtedness to Dr. W. L. Chandler of the Veterinary Division, under whose direction this work was carried on, for his suggestions and cooperation, to Professor C. G. Card, J. L. Boyd and J. M. Moore of the Poultry Division and to other members of the Division of Bacteriology for their kindly suggestions and assistance in this experimental work.