A STUDY OF PULLORUM DISEASE IN BABY CHICKS AS SHOWN BY THE EFFECTS OF DIFFERENT TEMPERATURES IN BROODING

THESIS FOR THE DEGREE OF M. S.

Leo R. Arnold

1932

A STUDY OF PULLORUM DISEASE IN BABY CHICKS AS SHOWN BY THE EFFECTS OF DIFFERENT TEMPERATURES IN BROODING

A STUDY OF PULLORUM DISEASE IN BABY CHICKS AS SHOWN BY THE EFFECTS OF DIFFERENT TEMPERATURES IN BROODING

Thesis

Respectfully submitted to the Graduate School of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of Master of Science.

by

Leo R. Arnold

1932

THESIS

ACKNOWLEDGMENTS

The writer takes great pleasure in expressing his gratitude to C. G. Card, Professor of Poultry Husbandry and J. M. Moore, Assistant Professor of Poultry Husbandry and W. L. Mallman, Research Assistant and Assistant Professor in Bacteriology, for their valuable suggestions and criticisms which have made this work possible.

It is also a pleasure to thank the Departments of Poultry Husbandry and Bacteriology for the use of stock, equipment, and materials in carrying on this experimental work.

TABLE OF CONTENTS

INTRODUCTION

Eradication of Pullorum disease, due to the nature of its transmission and dissemination, is a difficult problem. It has been conclusively demonstrated that the disease is transmitted through the egg from the infected hen to the chick during incubation and hatching. Complete elimination of reacting fowls from breeding flocks is suggested as the best method for eradication. This is costly and requires much time and effort.

In the commercial world two different view points are held, that of the hatcheryman and that of the purchaser of chicks. It has been requently observed that chicks from the same hatch when shipped to different points may show different results in livability and in spread of Pullorum disease. The hatcheryman is prone to believe that the chicks shipped out are livable chicks, and that any marked incidence of disease is caused by poor environment or improper care during the period of brooding. The overworked expressions, chilling, overheating, improper feeding, are given as causes of the heavy mortality which may occur. Though some authorities have minimized environment as a contributing factor, others feel that the heavy mortalities which occur in the brooding of infected chicks is due, to a great extent, to environmental conditions rather than to the nature of the disease itself.

Without doubt environment plays an important role not only in the spread of disease, but also in the susceptibility of the

host and the ultimate outcome of the disease as measured by resulting mortality rates. In the reduction of disease incidence and mortality rates of the human race, improved living conditions have undoubtedly played as important a part as the public health measures which have been instituted for the eradication of diseases.

As no direct information is available regarding Pullorum disease transmission and mortality rates brought about through such environmental factors as chilling, overheating and improper diet, the study of the effect of so-called adverse conditions on mortality rates and incidence of Pullorum disease was undertaken. This thesis contains the results of that study.

REVIEW OF LITERATURE AND GENERAL DISCUSSION

Although a voluminous literature exists on Pullorum disease, many points concerning means of transmission and means of control are still matters of controversy.

Pullorum disease was first observed in the latter part of the past century. It was not until 1899 that Rettger first isolated the causative organism and gave it the name, Bacterium pullorum. In a series of studies by Rettger and his co-workers it was demonstrated that this organism had a predilection for the ovaries of the hen. It was demonstrated that the disease was a germ cell transmission and that the germ, carried in the yolk of the egg, infected the developing embryo or the chick during the period of incubation or hatching. Many investigations of this disease have been made and results recorded. These have been very capably reviewed by Hooker (1). A long review of the various investigations is needless at this time. Only a few phases of the work will be discussed.

Rettger noted that Pullorum disease was particularly a chick ailment. Other investigators commented on the heavy mortality when an attack of this disease affected a flock of chicks. Jones (2), in 1909, reports results of inoculation of chicks with Bacterium pullorum. He found a mortality of 82.5 per cent in chicks subjected to inoculation whereas controls showed only two per cent mortality. Susceptibility was greater during the first twenty-four hours. Chicks inoculated after the fourth day seemed to be immune.

Rettger, Kirkpatrick, and Stoneburn (3) demonstrated susceptibility of chicks to inoculation of Bacterium pullorum. Chicks were infected with broth cultures fed through the mouth. High mortality resulted when infection occurred within three days after hatch. Low mortality was recorded when infection occurred at 108 hours or later.

In the same report the authors discuss litter infection, In this work a small amount of broth culture of Bacterium pullorum was sprinkled over the litter two or three times a week. Trials were made on three pens of pullets. Three untreated pens were used as check controls. Throughout theyear during which the experiment was conducted, no fowls in the check pens showed the presence of Bacterium pullorum in any way. Several fowls in the litter-infected pens did show presence of this organism. In another experiment carried on at the same time the authors demonstrated that infection may occur through spread from fowl to fowl.

Gage and Martin (4), in 1916, show heavy mortality due to infection. Bacterium pullorum was injected into fifty-three chicks, with a resulting loss of twenty-six within ten days. In ten chicks held as checks no loss occurred.

In 1923, Gage and Flint (5) make observations on the livability of chicks from disease free flocks. "During the year twenty-nine poultry plants in Massachusetts have been found free from bacillary white diarrhea. Previous to testing and before control measures were followed, all of these poultry plants suffered great losses.

"After a series of tests had indicated that there were no reactors in these twenty-nine flocks, this department sought to find where eggs had been sold for hatching, so that a record could be made of the value of the test. On one of the large farms where the breeding birds were infected with Bacterium pullorum it had become almost impossible to rear even a small percentage of the chicks hatched. During the present season, 1922-1923, the breeding flock was found to be free from birds which could be classed as carriers. Records were obtained from all persons receiving eggs for hatching from this flock. From 1,100 tested breeding birds, 11,600 eggs were incubated and 8,700 chicks hatched, 92.9 per cent of which were reared. This is considerably better than in 1919 when less than 15 per cent matured, the deaths in the first few days after hatching being due to infection with Bacterium pullorum.

In 1924, Gage and Flint (6) show continued results of their work on control. "Of the 20,665 day-old chicks sold from representative bacillary white diarrhea-free breeding flocks, aside from the three mentioned above, the livability averaged nearly 90 per cent. Many individual plants have reported that nearly 100 per cent of all chicks received from bacillary white diarrhea-free flocks were living and in good condition.

In 1925, Bransfield (7) reports on livability of chicks from disease-free flocks. He stated that livability of chicks from

such flocks was excellent. From twenty-five such flocks 26,497 chicks were hatched. Of these, 24,976 lived, or 92.26 per cent.

Canfield (8) observes heavy mortality in the progeny of hens showing Pullorum disease whereas livability is high in chicks hatched from eggs produced by disease-free fowls. In four different lots from both sources he records the following figures:
Per cent livability non-reacting hens - 87.09, 97.8, 92.5, 94.02.
Per cent livability reacting hens - 6.12, 32.69, ---, 22.40.

He remarks, "Of the chicks hatched from eggs laid by hens in the check lot, an average of 94.02 per cent were living and apparently vigorous on the fourteenth day, while an average of only 22.4 per cent of the chicks from reacting hens were living at that time. Of all the infected chicks living at the end of the fourteenth day only four showed any indications of recovery. The rest of the chicks appeared stunted and diseased". He also notes that greatest mortality occurred during the sixth and seventh days after hatching.

Observations of the effect of diet on Pullorum disease spread or control have been negligible. No investigators seem to feel that it has effect in increasing the spread of the disease in a flock. Some work has been done on feeding of milk in hopes of combating the disease.

In 1912 Rettger, Kirkpatrick, and Stoneburn (3) fed sour milk as a remedy or preventative. The following conclusions were given: "The feeding of sour milk to chicks appears to be a good

means of preventing or at least holding in check, epidemics of bacillary white diarrhea. The milk should be fed early; it should be kept before the chicks constantly. Sour milk has an important stimulating effect on growth and vitality of chicks".

Later sour milk feeding experiments (9) gave the same beneficial results recorded above but differ in one conclusion. The authors state, "As an important agent in the suppression of white diarrhea its value is somewhat doubtful".

Bushnell and Maurer (10) report in 1913 on feeding of milk cultures B.Bulgaricus as a menas of prevention. Beneficial results were reported, particularly when fed before infection took place. Twenty-seven chicks in each of three pens were used. In pen 1, B. Bulgaricus was fed within twenty-four hours after hatch; at forty hours Bacterium pullorum was fed. This feeding was continued until chicks were one week old. In pen 2 the chicks were given a culture of Bacterium pullorum within twenty-four hours. From then on both cultures were given. In pen 3 Bacterium pullorum was fed for one week, no B. Bulgaricus being given at all. Results are tabulated below:

No. Pen	Orig. No.	No. Alive	Sept. 23 No. dead of disease	Per cent dead of disease	Average Wt.
1	27	20	6	22	0.34
2	27	14	11	41	0.39
3	27	10	17	63	0.30
			Oct. 7		
1	27	15	10	37	0.53
2	27	9	16	60	0.61
3	27	4	23	85	0.56
			Oct. 21		
1	27	8	17	63	0.75
2	27	6	19	70	0.84
3	27	3	24	89	0.85

The authors state, "A comparison of our results with those of Rettger do not show any superiority of milk cultures of B. Bulgaricus over ordinary sour milk". However, they do conclude that B. Bulgaricus is effective in combating bacillary white diarrhea.

Continued work in regard to feeding of milk was reported by Rettger, Kirkpatrick, and Card (11) in 1915. It was found that there was practically no difference in results whether milk was fed sweet or sour. Nor did they find that milk soured with B. Bulgaricus had any advantage over naturally soured milk. Milk feeding did have value in preventing mortality in the flock. They felt that milk increased growth and vitality. Because of this the resistance of the chick was greater, making it less susceptible to infection.

During recent years much time has been given to a study of the incubator as a means of rapid dissemination of Pullorum disease.

Because of the many inquiries concerning incubators as a possible means of dissemination of infection, Hinshaw, Upp, and Moore (12) carried on work to determine whether or not such dissemination did actually occur.

They reported on results in 1926. They attacked the problem from three angles: (1) The bacteriology of incubator, (2) S. pullora infection of chicks through the nostrils, and (3) artifical dissemination of S. pullora infection in incubators.

They determined that there was a direct relationship between the time of incubation and the number of organisms in a machine of forced-air-draught type. After a thorough cleaning and disinfection

of the incubator few organisms were present. The number greatly increased during the hatch. In the still air machine the number of organisms remained approximately the same throughout the period of incubation.

Through treatment of chicks with cultures it was determined that infection could take place through the nostrils. It was assumed that many chicks did thus become infected through the breathing in of floating chick down during the period of hatch,

Infected chick down was placed in forced-air draught type machines. A control lot was hatched in a machine in which no infected down was placed. Results of fourteen days of brooding of the chicks which were hatched out demonstrated conclusively that dissemination of the disease could occur through infected down. Other similar experiments gave the same results.

In 1928, Hinshaw, Scott, and Payne (13) report on a series of experiments conducted to check the work of Hinshaw, Upp, and Moore. Natural infection was allowed to play its part in this work. It was found that chicks hatched from normal eggs incubated adjacent to eggs from reacting hens, but in different trays, showed a heavy mortality from Pullorum disease. When the trays holding normal eggs were placed in the opposite end of the machine from the eggs of reacting hens, mortality from the disease was much less.

Bunyea and Hall (14) found that Pullorum disease was transmitted from diseased chicks to healthy chicks by exposure in an incubator within eighteen to twenty-four hours from the time of

hatching, without actual contact between chicks. Their results showed a greater amount of infection in the agitated-air type machine than in the still-air type. All machines used permitted the transmission of the disease.

Gwatkin (15) in a series of experiments on disinfection of incubators demonstrated that successful fumigation could be obtained, without injury to the hatch, by applying the fumigating material to the machine six or eight times during the course of the incubation.

Marcellus, Gwatkin, and Glover (16) demonstrated that satisfactory disinfection of forced-draught incubators was possible through the application of formalin and potassium permanganate.

In 1929, Dakan and Speer (17) reports on results obtained from fumigation of incubators. The results show a much higher mortality from Pullorum disease in the chicks hatched in the incubator not fumigated in comparison to mortality of chicks hatched in the fumigated incubator.

No exact determination of optimum temperature in the brooding of chicks has been made. Recommendations as to proper hover temperature have differed somewhat. Poultrymen have always avoided, as far as possible, great fluctuations of temperature during brooding. All poultrymen have believed that hover temperature held for any considerable length of time too much above or too much below the optimum temperature give poor results in brooding. Little experimental work has been done to show just what the effects of

abnormal temperatures might be. No information is available which shows effects of temperature on the incidence of Pullorum disease.

Parker (18) reports some of the effects of overheating and chilling as regards mortality, yolk weights, and chick weights. Some differences of yolk weights were observed in the chicks examined during the period of actual exposure to temperatures above or below the optimum. However, observations at later ages showed no evidence of any permanent effect upon yolk absorption.

Overheating and chilling did not result in higher mortality than occurred in the controls.

Figures submitted show no significant differences in body weights for either sex at any age due to abnormal temperatures. Weights taken of male chicks after the fifth week show the body weights of those subjected to chilling and overheating to be slightly more than the controls, but not significantly so. The females in the overheated lot were slightly heavier at all ages, and in the chilled lots at all ages after three weeks.

The author considers it unfortunate that the temperatures were not made more severe.

EXPERIMENTAL WORK

Object of the Experiment

This experiment was planned for the observation of the mortality of chicks from Pullorum disease during the first two weeks after the hatch. The chicks were subjected to adverse conditions such as might prevail during shipment from the hatchery to the farm, and during the first two weeks of brooding. Chicks reared under normal conditions were to be employed as checks.

Chicks from two different sources were used. Stock from a commercial hatchery which had taken no preventative steps toward elimination of Pullorum disease was to constitute one source (referred to in data as Stock B); in contrast, chicks from the Poultry Research Plant, Michigan State College were to be used (Stock A). At this plant one agglutination test had been applied annually during the five previous years. Mortality from this disease had been negligible.

The problem was, "Would chicks from the commercial hatchery show varying degrees of mortality, due to Bacterium pullorum, in the different lots held under different conditions? How would the chicks from the other sources react to these conditions?"

Conditions were to approach what might be termed"natural conditions", that is, conditions which might occur to chicks after leaving the hatchery.

Plan of the Experiment

The experiment was divided into two series of trials, as follows:

A. (1) To subject day-old chicks from the two sources to four different controlled temperatures during the first week of brooding. During the second week the chicks were to be brooded under normal conditions in cardboard brooders with wire-cloth bottoms.

(2) The four temperatures employed during the first week: Pen 1, 72 degrees F.; Pen 2, 80 degrees F.; Pen 3, 88 degrees F.; Pen 4, 96 degrees F.

(3) To confine chicks from both sources together in four different compartments during the two weeks.

(4) To give the same care, feed, and attention to all lots. The one exception to be the different temperatures.

(5) To keep mortality records during the two weeks.

(6) To determine mortality from Bacterium pullorum.

(7) To keep records of average weights of the chicks at the end of the two weeks.

B. (1) To subject chicks from two sources to low temperatures. This to be done one day after hatch.

(2) To subject the lots of chicks to the same temperature, but to different lengths of time.

(3) To remove the chicks immediately after subjection to cold temperatures to cardboard boxes as described above.

(4), (5), (6) and (7) same as in A.

Procedure

Day-old chicks were used in this experiment. The chicks from the commercial hatchery were hatched in still-air incubators; those from the College Plant were hatched in a forced-draught machine. Hatchability in the latter case was high. No figures were obtainable in the case of the commercial hatchery stock.

In Experiment A, all chicks were of the Single Comb Rhode Island Red variety. In Experiment B, Barred Rock chicks were used in the case of College Stock.

Feeding and Brooding

All chicks fed an all-mash mixture, Spartan Starter. This was placed before the chicks at the time they were put in the brooders and they had access to this feed at all times.

In the case of chicks under Experiment A, a special brooder was designed. A description of this is given below. At one week of age these chicks were transferred to the cardboard boxes with wire-cloth bottoms. In Experiment B, all chicks were confined during the two weeks in the cardboard boxes. Fifty-watt electric bulbs were used to supply heat within the boxes.

Brooding took place in a class room in the Service Building at the College Poultry Research Plant. This room was well lighted during the day. Its temperature was controlled at 70 degrees F. by means of a thermostat.

In the chilling experiment chicks from both sources were exposed to low temperatures in the refrigerator room of the service

building one day after hatch. Temperature was held constant throughout the period of exposure.

Upon removal of the chicks they were placed in cardboard brooders with wire bottoms, and confined in these brooders for a period of two weeks.

Chicks dying during the two weeks period were examined for Bacterium pullorum in the Bacteriology Building of Michigan State College.

At the end of the two weeks period, part of the chicks from both sources were killed and examined.

The Experimental Brooder

The experimental brooder in which the chicks were brooded is explained by a blue print placed in the back cover, of this thesis. The details of the brooder were worked out by Professor O. E. Robey of the Agricultural Engineering Department. Each of the four compartments was thoroughly insulated and thermostatically controlled so that it was possible to hold the temperature constant to within one degree anywhere in the same compartment (at points equidistant from the floor). Three-quarter inch holes, four inches apart at the front and rear, provided a gentle circulation of air. The room in which the brooder was operated was held at 70 degrees F.

Photographs of the experimental brooder will be found in the Appendix.

DISCUSSION OF DATA

Subjection to Different Temperatures in the Experimental brooder

In the trials with both A and B stock held together under different temperatures, the chicks from both sources were apparently of the same vigor. Data for these trials are shown in Tables I to VII. Initial weights were so nearly the same that any difference was negligible. During the first week the chicks held at 88° F. and 96° F. seemed to do better than those held at 72° F and 80 ° F. They were more comfortalbe, ate more food, and drank more water. The chicks held at 72° F. were huddled much of the time. When transferred at the end of the week to other quarters, the chicks in Pen I held at 72° F. appeared to be in poorer condition than any of the others. However, they apparently recovered from this condition during the second week, and in most cases were equal in weight to the others at the end of the experiment.

The average weights of all chicks alive at the end of the two weeks period as recorded in Tables II to VII in the Appendix show equal average weight for both A and B Stock in Pen I. In Pen II, average weights for A and B Stock were 2.46 ounces and 2.47 ounces, respectively; in Pen III the A Stock averaged 2.41 ounces in comparison to 2.46 ounces for B Stock; in Pen IV the A Stock showed a much better weight, the figures being 2.48 for A Stock to 2.28 for B. Stock.

Mortality, as shown in Tables IX to XII, was consistently higher in the B Stock throughout the seven trials. Figures on percentage of mortality show in most of the trials a lessening of mortality as temperatures increases. This was true of both A and B Stock. Of the seven trials the average mortality ran in a descending scale from Pen I to Pen IV. As the temperature rose, mortality lessened. For A Stock the figures (in per cent) for the four pens in their numerical order are: 37.5, 15.3, 13.6, 5.7; corresponding figures for B Stock are: 57.2, 49.6, 42.3 and 32.1.

Of the 124 chicks of A Stock run as a check (Table VIII in Appendix) there was a mortality of only two chicks. No Bacterium pullorum was found in the lot used as a check. In the seven trials (Tables I to VII) in which A Stock was confined with B Stock mortality due to Pullorum disease was found in A Stock. However, the figuresare not significant as far as effect of different temperatures are concerned. The per cent infection in A Stock of all chicks which died and were examined, Pens I to IV respectively, was: 25.0, 11.8, 28.6, and 14.3. This is shown in Tables IX to XII. In the case of B Stock, temperature likewise appeared to have little effect upon the amount of infection. Per cent infection of examined chicks for the same four pens was: 75.3, 77.6, 87.5 and 82.1. These data would indicate that the lower temperature, 72° F. regarded as an adverse condition, had no effect in bringing out or aggravating the disease.

The eighth trial ran with A Stock as a check (Table VIII) showed a mortality of only 1.6 per cent. As Pullorum disease was not found in the two chicks which died, nor in the 60 which were examined at two weeks of age, it is very probable that such infection as did occur in trials one to seven was due to confinement of A Stock with B Stock.

In all probability the chicks alive at the end of two weeks would have survived without much loss thereafter. Pullorum infection was present, but there were few apparent symptoms in the live chicks. Tables IX to XII show infection present in the chicks killed at two weeks of age. In both A and B Stock there was a slightly higher percentage of infection present in Pen I than in the other pens, but not enough difference exists to lead one to believe that low temperature was necessarily responsible for it. The much higher percentage of infection of B chicks over that of A chicks in all pens, in both cases where the chicks died in the pens and when killed at two weeks, plus the fact that no infection is shown in Table VIII, (control), indicates very strongly that B Stock was infected at time of hatch.

Day-old B Stock was not killed throughout the trials, but at the time the last two purchases of such chicks were made some were killed and examined. In the first instance out of 16 chicks, four showed infection. In the second instance, there was no

infection shown in the 15 killed when one-day old. The remainder of the chicks of this purchase were used in the chilling experiment. There was a mortality of only one chick in forty-six held for two weeks. Thirty of these were killed with no infection present as shown in Table XV. Evidently in this hatch the hatcheryman had furnished chicks coming from a different source than was the case in other hatches.

Heaviest losses in both A and B Stock occurred at about the same time, as shown in Table XIII. The graphs in the Appendix indicate daily percentage of losses. Mortality in B Stock generally started a little before mortality in A Stock. In B Stock, 75 per cent of the total mortality occurred during the third, fourth, fifth and sixth days. In A Stock heavy losses started on the fourth day. During the fourth, fifth, and sixth days there was a 63 per cent loss of all chicks that died.

Mortality in B Stock was much heavier in some trials than in others. The second and third trials (Tables II and III) show an exceptionally high loss. Tables VI and VII show low mortality compared to the others. At the time mortality was exceedingly high, percentage of infection was likewise high. In Table XIII, a summation of all mortality occurring in both Stock A and B held at the four temperatures shows a much higher loss in Stock B. Losses in the control groups were very low.

Subjection to Chilling Temperatures

In the subjection of chicks to chilling temperatures three trials were conducted on College Stock alone as shown in Tables XIV to XVI. In the first trial the chicks were held only twenty, thirty and forty minutes at 4° C. They huddled considerably and did much chirping, but none were overcome in any way. Within a few minutes after being placed in the brooder with heat they were in good condition. No after-effects of the exposure were apparent at any time.

Three lots were exposed at -2° C. for 70, 100, and 130 minutes, respectively, as shown in Table XV. In this instance, the chicks were in bad condition when removed to brooders. In Pen I, those held to this temperature for 70 minutes were, in many cases, stiff at time of removal. In Pens II and III, all were overcome by the cold. In Pen II, eight were dead when removed and the others showed little life. In Pen III, twelve were dead at time of removal and the remainder showed little life. However, after a few hours in the brooder they recovered. After removal of the dead chicks at time of exposure, mortality was low, and all the chicks seemed normal throughout the two weeks.

In a third trial the chicks were held at -1° C. for 90, 120, and 150 minutes. See Table XVI. In Pen I, several were unable to move at the end of 90 minutes, but all recovered in the brooder. In Pen II, three dead chicks were removed at the end of the 120 minutes, and all others were unable to stand. Those subjected to

150 minutes in the cold room showed a mortality of twenty-five out of thirty-eight. All of the other thirteen were lifeless in appearance. However, they recovered in the brooder and were apparently normal.

Of all the chicks examined only two cases of Bacterium pullorum were found. These were found in the first hatch subjected to 4° C. temperatures and for only twenty and thirty minutes.

Three trials were run in which both A and B Stock were used. There were two pens of both A and B Stock in all three trials. Figures are given in Tables XVII to XIX.

Tables XVII and XVIII show the first two of these trials. The chicks in Pen I were held in the cold temperature for 70 minutes, and in Pen II they were held for 130 minutes.

In the first of these two trials the temperature was 1°C. There was no mortality during the time the chicks were being subjected to the cold temperature, but many of the chicks were so completely overcome that they were stiffened. This was particularly true of the chicks which were held for 130 minutes. They apparently recovered within a few hours. There was no mortality at all during the two weeks in Pen I for the A Stock, and only a loss of seven out of fifty-two in Pen II.

A heavier mortality occurred in the case of B Stock. In Pen I, the mortality was 35 per cent, in Pen II, only 15 per cent. There was infection present in bothpens, but the percentage was

about the same in both cases.

In the next trial, as shown in Table XVIII, in which the chicks were confined at 0° C. for the same lengths of time as before there was a loss directly due to the exposure. Six chicks of the 112 of A Stock died immediately after removal to the brooder, and one of B Stock also died. The condition of the chicks was the same as described above. All seemed to recover, but losses were greater.

Pullorum disease was present in B Stock to about the same extent as in the first trial.

In the third trial, Table XIX, the temperature was held at 2° C, the limits of time being 90 and 150 minutes. No loss occurred during exposure and mortality was low during the two weeks the chicks were held in the brooders. In this trial there was no loss at all from Pullorum disease. This is the only case in which no loss from this disease was recorded for B Stock. No B chicks from this hatch were being held at the different temperatures, as the check lot of A chicks was being run at that time. It is very probable that the hatchery furnished chicks which were hatched from eggs coming from a different farm than was the case in the otherlots received from the hatchery.

A comparison of results in B chicks chilled and B chicks held at 96° F. (Table XX) shows little to indicate that adverse conditions have much to do with the outbreak or spread of the disease. Mortality in the case of the 128 chilled chicks was

25 per cent as compared to 32.1 per cent in chicks held at 96°F. Per cent infection of the chicks which died and were examined during the fourteen days was 76.9 in the chilled chicks and 82.1 in the other case. Of the chicks killed at the end of the experiment the per cent was 25.7 and 30.5.

If one were to cast out the figures for B Stock as given in Table XIX the figures on chilling and heating would coincide more closely. In the trial shown in Table XIX no infection was present in B stock; thus the mortality percentage is lower, also infection percentage. No chicks of this hatch were held in the experimental brooder.

CONCLUSIONS

From the data obtained the following conclusions might be drawn:

1. That low brooder temperature has no effect upon the incidence of Pullorum disease.
2. That subjection of chicks, for a limited time, to such low temperature that death results in some cases has no effect upon the incidence of Pullorum disease in chicks.
3. That low temperatures may affect mortality rates, but the lowering of vitality from such cause has little effect upon prevalence of Pullorum disease in chicks.

LITERATURE CITED

1. Hooker, W.A.

Investigations on Bacillary White Diarrhea Infection of Fowls.

Report on Agricultural Experiment Stations, 1925.

2. Jones, F.S.

An outbreak of an acute disease in adult fowls due to

Bacterium pullorum.

Journal of Medical Research, 27:154-85, 1913.

3. Rettger, L.F., Kirkpatrick, W.F., and Stoneburn, F.H.

Bacillary White Diarrhea of Young Chicks.

Connecticut Experiment Station Bulletin, 74:153,1912.

4. Gage, G.E., and Martin, J. F.

Notes on Histo-Pathology of the Intestines of Young

Chicks Infected with Pullorum Disease.

Journal Medical Research, 34:149, 1916.

5. Gage, G.E., and Flint, O.S.

Control of Bacillary White Diarrhea.

Massachusetts Experiment Station Control Series Bulletin 23:7,1923.

6. Gage, G.E., and Flint, O.S.

Control of Bacillary White Diarrhea

Massachusetts Experiment Station Control Series, 27:8, 1924.

7. Bransfield, P.E.

Control of Bacillary White Diarrhea.

Massachusetts Experiment Station Control Series, 31:6, 1925.

8. Canfield, H.

The Effects of Bacillary White Diarrhea.

Michigan Station Quarterly Bulletin 8:31-32, 1925.

9. Rettger, L.F., Kirkpatrick, W.F., and Jones, R.E.

Bacillary White Diarrhea in Young Chicks.

Connecticut Experiment Station Bulletin 77:263-307, 1914.

10. Bushnell, L. D., and Maurer, O.

The Use of Milk Cultures of B. Bulgaricus in the Preventation and Treatment of Bacillary White Diarrhea.

American Vet. Review, 44:194-207, 1913.

11. Rettger, L.F., Kirkpatrick, W.F., and Card, L. E.

Milk Feeding and Its Influence on Growth and Mortality; Comparative Study of the Value of Sweet and Sour Milk.

Connecticut Experiment Station Bulletin 80:28, 1915.

12. Hinshaw, W.R., Upp, C.W., and Moore, J. M.

Studies in the Transmission of Bacillary White Diarrhea in Incubators.

Journal Amer. Vet. Association,66:631-41, 1926 .

13. Hinshaw, W.R., Scott, H.M., and Payne, L.F.

Further Studies on Dissemination of Salmonella Pullorum Infection in Incubators.

Journal Amer. Vet. Association,72:549-610, 1927.

14. Bunyea, H., and Hall, W.J.

A Review of Two Years Work in Pullorum.

An Address delivered at Fifth National Poultry Congress, December, 1929. Published by National Poultry Congress,pp.8.

15. Gwatkin, R.

Some Experiments on the Disinfection of Eggs and Incubators.

Report of Ontario Vet. College, 1926, pp. 58-65.

16. Marcellus, F. N., Gwatkin, R., and Glover, J.S.

Incubator Disinfection in Control of S. pullora.

Conference papers on disease and its control, Fourth

World's Poultry Congress, pp. 373-78.

17. Dakan, E.L., and Speer, Fred.

Sanitation in the Hatchery.

Ohio State University Extension Service Bulletin 90:1-16,1929.

18. Parker

Effects of Early Handicaps on Chickens as Measured by Yolk

Absorption and Body Weights to Twenty Weeks of Age.

Hilgardia, 4:28-36, 1929.

APPENDIX

TABLE NO. I

DAILY MORTALITY and PER CENT INFECTION OF PULLORUM DISEASE

FIRST TRIAL - MARCH 8, 1932

Temperature	Pen Number	Lot	Number Chicks	Daily Mortality 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Per Cent Mortality	Chicks Examined (Died)	Infected Chicks	Per Cent Infected	Killed at 2 weeks Examined	Infected Chicks	Per Cent Infected	Ave. Wt. at 2 weeks
72	I	A	19				1	3	1	1								31.6	6	3	50.0	5	0	0.0	
		B	22			4	2	2	2	2								54.5	12	7	58.3	8	2	25.0	
80	II	A	22		1			4										23.6	5	1	20.0	5	0	0.0	
		B	20		1		4	3	1									45.0	9	3	33.3	8	0	0.0	
88	III	A	22									1						4.5	1	0	0.0	5	1	20.0	
		B	19					2	3					1	1			36.9	5	4	80.0	7	0	0.0	
96	IV	A	21											1				4.8	1	0	0.0	5	0	0.0	
		B	19									1						5.3	1	1	100.0	8	2	25.0	

TABLE NO II

DAILY MORTALITY and PER CENT INFECTION OF PULLORUM DISEASE

SECOND TRIAL - MARCH 15,1932

Temperature	Pen	Lot	Number Chicks	Daily Mortality 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Per Cent Mortality Chicks Examined (Died)	Infected Chicks	Per Cent Infected Killed at 2 weeks Examined	Infected Chicks	Per Cent Infected	Ave. Wt. at 2 Weeks
72	I	A	20		1	1	5	3	4					1				75.0	14	3	21.4				2.6
		B	19			6	5	4	3									94.7	18	16	88.8				
80	II	A	20				1	1	1									15.0	2	0	0.0				2.75
		B	19		1	3	5	5	3									89.4	17	15	88.2				2.20
88	III	A	20					1	1	1								15.0	3	1	33.3				2.65
		B	19	1	1	2	2	2	4	2			2					84.2	13	12	92.3				2.30
96	IV	A	20	2														10.0	2	1	50.0				2.67
		B	19	2	1		1	2	4		1	1		1				68.4	13	10	76.9				2.50

TABLE NO. III

DAILY MORTALITY and PER CENT INFECTION OF PULLORUM DISEASE

THIRD TRIAL - MARCH 22, 1932

Temperature	Pen	Lot	Number Chicks	Daily Mortality 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Per Cent Mortality	Chicks Examined (Died)	Infected Chicks	Per Cent Infected	Killed at 2 weeks Examined	Infected Chicks	Per Cent Infected	Ave. Wt. at 2 Weeks
72	I	A	20				4	1	2									35.0	7	3	42.8				2.34
		B	20		1	11	5		3									100.0	20	20	100.0				
80	II	A	20				1			1					1			15.0	3	1	33.3				2.49
		B	21			4	4	5	6									90.5	19	19	100.0				
88	III	A	20					1		1			1		1	1		25.0	3	2	66.7				2.47
		B	21			3	9	6	3									100.0	17	17	100.0				
96	~~IV~~	A	20								1	1						10.0	2	0	0.0				2.36
		B	21				3	4	3	3	4							81.0	13	13	100.0				1.92

TABLE NO. IV

DAILY MORTALITY and PER CENT INFECTION OF PULLORUM DISEASE

FOURTH TRIAL - MARCH 29, 1932

Temperature	Pen	Lot	Number Chicks	Daily Mortality 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Per Cent Mortality Chicks Examined (Died)	Infected Chicks	Per Cent Infected	Killed at 2 Weeks Examined	Infected Chicks	Per Cent Infected	Ave. Wt. at 2 Weeks
72	I	A	12				5	2										58.3	7	0	0.0	5	0	0.0	2.18
		B	20		1	7	1	2	3				1					75.0	13	5	38.5	5	2	40.0	2.94
80	II	A	13					5	1									46.2	5	0	0.0	5	0	0.0	2.35
		B	20		1	8	2	2										65.0	13	6	46.1	7	1	14.3	2.40
88	III	A	13						1									7.7	1	1	100.0	5	0	0.0	2.17
		B	21			1	1					1						14.3	3	1	33.3	18	5	27.2	2.36
96	IV	A	11															0.0				5	0	0.0	2.36
		B	21			1		1				1	1					19.0	3	2	66.6	17	2	11.8	2.14

TABLE NO. V

DAILY MORTALITY and PER CENT INFECTION OF PULLORUM DISEASE

FIFTH TRIAL - APRIL 5, 1932

Temperature	Pen	Lot	Number Chicks	Daily Mortality 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Per Cent Mortality	Chicks Examined (Died)	Infected Chicks	Per Cent Infected	Killed at 2 Weeks Examined	Infected Chicks	Per Cent Infected	Ave. Wt. at 2 Weeks
72	I	A	12						2	1								25.0	3	0	0.0	8	3	37.5	2.13
		B	20					2		3		1				1	2	45.0	9	6	66.7	10	7	70.0	2.31
80	II	A	12							1								8.3	1	0	0.0	8	0	0.0	2.40
		B	20					1	1	2	1	1	1				1	40.0	7	7	100.0	12	6	50.0	2.13
88	III	A	13								1							7.7	1	0	0.0	8	1	12.5	2.37
		B	20					2	1	3			1	1				40.0	8	7	87.5	12	5	62.5	2.41
96	IV	A	13								1							7.7	1	0	0.0	7	1	14.3	2.53
		B	20				1	2		2	1			1				35.0	7	5	71.4	11	8	72.7	2.19

TABLE NO. VI

DAILY MORTALITY and PER CENT INFECTION OF PULLORUM DISEASE

SIXTH TRIAL - APRIL 12, 1932

Temperature	Pen	Lot	Number Chicks	Daily Mortality 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Per Cent Mortality	Chicks Examined (Died)	Infected Chicks	Per Cent Infected	Killed at 2 Weeks Examined	Infected Chicks	Per Cent Infected	Ave. Wt. at 2 Weeks
72	I	A	20							1		2						15.0	3	0	0.0	6	0	0.0	2.72
		B	20						1									5.0	1	0	0.0	13	1	7.7	2.56
80	II	A	20																			7	3	42.9	2.10
		B	20							1								5.0	1	1	100.0	13	4	30.8	2.44
88	III	A	20					1						1	1			15.0	2	0	0.0	7	0	0.0	2.24
		B	20							1								5.0				13	5	38.4	2.66
96	IV	A	20																			7	0	0.0	2.20
		B	20												1			5.0	1	0	0.0	13	1	7.7	2.37

TABLE NO. VII·

DAILY MORTALITY and PER CENT INFECTION OF PULLORUM DISEASE

SEVENTH TRIAL - APRIL 19, 1932

Temperature	Pen	Lot	Number Chicks	Daily Mortality 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Per Cent Mortality	Chicks Examined (Died)	Infected Chicks	Per Cent Infected	Killed at 2 Weeks Examined	Infected Chicks	Per Cent Infected	Ave. Wt. at 2 Weeks
72	I	A	17		1		1		1				1					23.5	4	2	50.0	6	1	16.7	2.52
		B	17				2		1	1								23.5	4	4	100.0	10	7	70.0	2.32
80	II	A	17								1							5.9	1	0	0.0	6	0	0.0	2.72
		B	17					1										5.9	1	1	100.0	10	2	20.0	2.51
88	III	A	17		1	1					1							18.2	3	0	0.0	6	1	16.7	2.53
		B	17								1					1		11.8	2	1	50.0	10	6	60.0	2.48
96	IV	A	17				1											5.9	1	0	0.0	6	1	16.7	2.77
		B	17													1		5.9	1	1	100.0	10	5	50.0	2.39

TABLE NO. VIII

PER CENT MORTALITY and PER CENT INFECTION (Bact.Pullorum) IN COLLEGE STOCK (A)

EIGHTH TRIAL - APRIL 26, 1932

Temperature	Pen	Lot	Number Chicks	Daily Mortality 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Per Cent Mortality Chicks Examined (Died)	Infected Chicks	Per Cent Infected Chicks Examined Killed at 2 weeks	Infected Chicks	Per Cent Infected	Ave. Wt. at 2 Weeks
72	1	A	31																	15			2.00
80	2	A	31					1										3.29	1	15			2.72
88	3	A	31							1								3.29	1	15			2.68
96	4	A	31																	15			2.75

TABLE NO. IX

PER CENT MORTALITY IN CHICKS and PER CENT INFECTION (BACT. PULLORUM)

IN CHICKS EXAMINED

Pen I

	Lot A									Lot B								
Date of Hatch	Number of Chicks	Mortality	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected	Number of Chicks	Mortality	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected
3/8	19	6	31.6	6	3	50.0	5	0	0.0	22	12	54.5	12	7	58.3	8	2	25.0
3/15	20	15	75.0	14	3	21.4	-	-	- -	19	18	94.7	18	16	88.8	-	-	----
3/12	20	7	35.0	7	3	42.8	-	-	- -	20	20	100.0	20	20	100.0	-	-	----
3/29	12	7	58.3	7	0	0.0	5	0	0.0	20	15	75.0	15	5	33.5	5	2	40.0
4/5	12	3	25.0	3	0	0.0	8	3	37.5	20	9	45.0	9	6	66.7	10	7	70.0
4/12	20	3	15.0	3	0	0.0	6	0	0.0	20	1	5.0	1	0	0.0	13	1	7.7
4/19	17	4	23.5	4	2	50.0	6	1	16.7	17	4	23.5	4	4	100.0	10	7	70.0
	120	45	37.5	44	11	25.0	30	4	13.3	138	79	57.2	77	58	75.3	46	19	41.3

TABLE NO. X

PER CENT MORTALITY IN CHICKS and PER CENT INFECTION (BACT. PULLORUM)

IN CHICKS EXAMINED

Pen II

Date of Hatch	Lot A									Lot B								
	Number of Chicks	Mortality	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected	Number of Chicks	Mortality	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected
3/8	22	5	23.6	5	1	20.0	5	0	0.0	20	9	45.0	9	3	33.3	8	0	0.0
3/15	20	3	15.0	2	0	0.0	-	-	--	19	17	89.4	17	15	88.2	-	-	--
3/20	20	3	15.0	3	1	33.3	-	-	--	21	19	90.5	19	19	100.0	-	-	--
3/29	13	6	46.2	5	0	0.0	5	0	0.0	20	13	65.0	13	6	46.1	7	1	14.3
4/5	12	1	8.3	1	0	0.0	8	0	0.0	20	8	40.0	7	7	100.0	12	6	50.0
4/12	20	0	0.0	-	-	--	7	3	42.9	20	1	5.0	1	1	100.0	13	4	30.8
4/19	17	1	5.9	1	0	0.0	6	0	0.0	17	1	5.9	1	1	100.0	10	2	20.0
	124	19	15.3	17	2	11.8	31	3	9.7	137	68	49.6	67	52	77.6	50	13	26.0

TABLE NO. XI

PER CENT MORTALITY IN CHICKSand PER CENT INFECTION (BACT. PULLORUM)

IN CHICKS EXAMINED

Pen III

	Lot A									Lot B								
Date of Hatch	Number of Chicks	Mortality	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected	Number of Chicks	Mortality	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected
3/8	22	1	4.5	1	0	0.0	5	1	20.0	19	7	36.9	5	4	80.0	7	0	0.0
3/15	20	3	15.0	3	1	33.3	-	-	---	19	16	84.2	13	12	92.3	-	-	---
3/22	20	5	25.0	3	2	66.7	-	-	---	21	21	100.0	17	17	100.0	-	-	---
3/29	13	1	7.7	1	1	100.0	5	0	0.0	21	3	14.3	3	1	33.3	18	5	27.2
4/5	13	1	7.7	1	0	0.0	8	1	12.5	20	8	40.0	8	7	87.5	12	5	62.5
4/12	20	3	15.0	2	0	0.0	7	0	0.0	20	1	5.0	-	-	---	13	5	38.4
4/19	17	3	18.2	3	0	0.0	6	1	16.7	17	2	11.8	2	1	50.0	10	6	60.0
	125	17	13.6	14	4	28.6	31	3	9.7	137	58	42.3	48	42	87.5	60	21	35.0

TABLE NO. XII

PER CENT MORTALITY IN CHICKS and PER CENT INFECTION

(BACT. PULLORUM) IN CHICKS EXAMINED

Pen IV

	Lot A									Lot B								
Date of Hatch	Number of Chicks	Mortality	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected	Number of Chicks	Mortality	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected
3/8	21	1	4.8	1	0	0.0	5	0	0.0	19	1	5.3	1	1	100.0	8	2	25.0
3/15	20	2	10.0	2	1	50.0	-	-	---	19	13	68.4	13	10	76.9	-	-	---
3/22	20	2	10.0	2	0	0.0	-	-	---	21	17	81.0	13	13	100.0	-	-	---
3/29	11	0	0.0	-	-	---	5	0	0.0	21	4	19.0	3	2	66.7	17	2	11.8
4/5	13	1	7.7	1	0	0.0	7	1	14.3	20	7	35.0	7	5	71.4	11	8	72.7
4/12	20	0	0.0	-	-	---	7	0	0.0	20	1	5.0	1	0	0.0	13	1	7.7
4/19	17	1	5.9	1	0	0.0	6	1	16.7	17	1	5.9	1	1	100.0	10	5	50.0
	122	7	5.7	7	1	14.3	30	2	6.7	137	44	32.1	39	32	82.1	59	18	30.5

TABLE NO. XIII

DAILY MORTALITY OF CHICKS HELD AT DIFFERENT TEMPERATURES

SUMMARY OF ALL TRIALS

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Per Cent
Stock A	491	2	4	2	20	22	14	6	5	4	2	3	3	1		88	17.9
Stock B	549	3	7	50	47	48	42	20	8	6	6	4	2	3	3	249	45.4
Stock A, Control	124					1		1								2	1.6

TABLE NO. XIV

PER CENT MORTALITY and PER CENT INFECTION (BACT. PULLORUM)

IN EXAMINED CHICKS

CHICKS EXPOSED TO CHILLING TEMPERATURES

Stock A (College Stock)

Trial One

Temperature	Time Exposed (Minutes)	Lot	Number Chicks	Mortality by Days 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected	Ave. Wt. in Oz. at 2 Weeks
4°C	20	1	67		1	1			1			2						7.5	5	0	0.0	10	1	10.0	
4°C	30	2	67															—	-	-	—	10	1	10.0	
4°C	40	3	67															—	-	-	—	10	0	0.0	

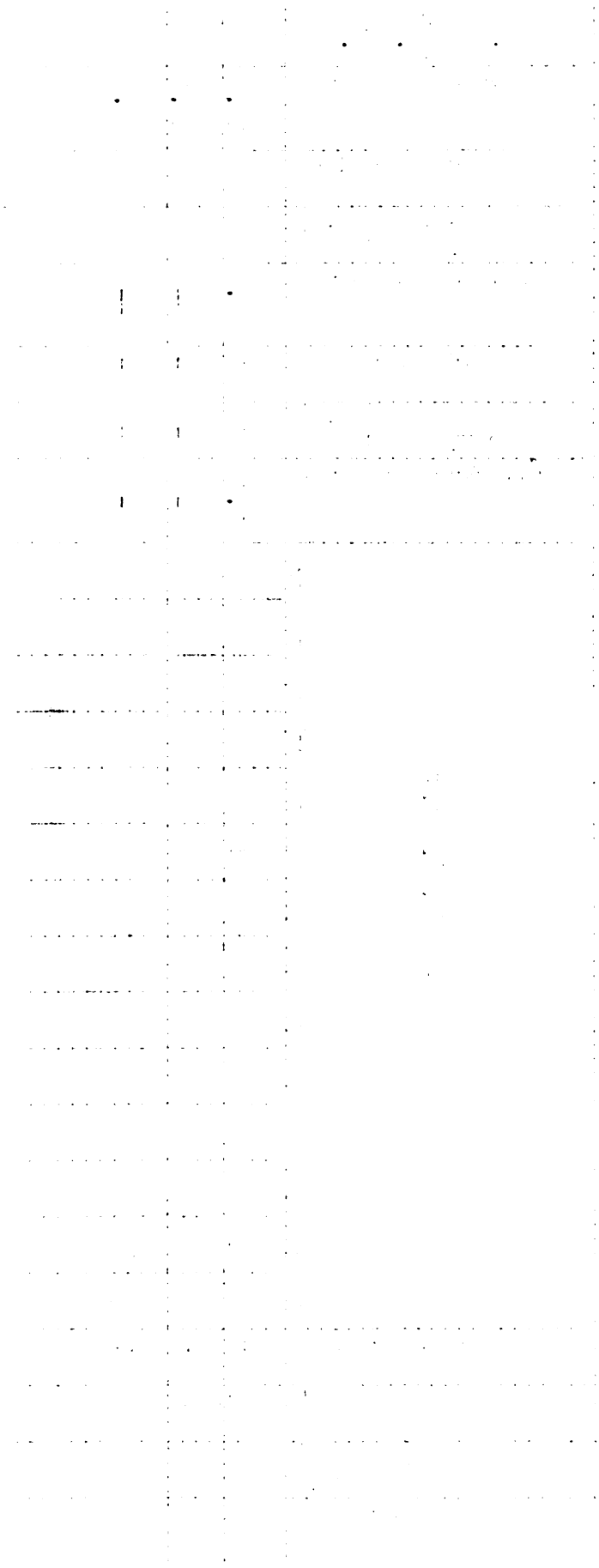


TABLE NO. XV

PER CENT MORTALITY and PER CENT INFECTION (BACT. PULLORUM)

IN EXAMINED CHICKS

CHICKS EXPOSED TO CHILLING TEMPERATURES

Stock A (College Stock)

Trial Two

Temperature	Time Exposed	Lot Number	Number of Chicks	Mortality by Days														Per Cent Mortality Chicks Examined (Died)	Number Infected	Per Cent Infected Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected (Ave. Wt. in Os. at 2 weeks
				1	2	3	4	5	6	7	8	9	10	11	12	13	14					
-2°C	70	1	40		3	1	1									1		15.0	6	0.0	5	0	0.0	2.65
-2°C	100	2	40	8*		1			1						1			27.5	5	0.0	5	0	0.0	2.49
-2°C	150	3	40	12*									1					32.5	1	0.0	5	0	0.0	2.61

* Died during exposure or immediately after.

TABLE NO. XVI

PER CENT MORTALITY and PER CENT INFECTION (BACT. PULLORUM) IN EXAMINED CHICKS

CHICKS EXPOSED TO CHILLING TEMPERATURES

Stock A (College Stock)

Trial Three

Temperature	Time Exposed	Lot Number	Number Chicks	Mortality by Days														Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected	Ave. Wt. in Oz. at 2 weeks
				1	2	3	4	5	6	7	8	9	10	11	12	13	14								
-1°C	90	1	58			1					1							5.3	2	0	0.0	5	0	0.0	2.65
-1°C	120	2	58	3*	1													10.5	1	0	0.0	5	0	0.0	2.75
-1°C	150	3	58	25*		1												68.4	1	0	0.0	5	0	0.0	2.80

* Died during exposure or immediately after.

TABLE NO. XVII

PER CENT MORTALITY and PER CENT INFECTION (BACT. PULLORUM) IN EXAMINED CHICKS

CHICKS EXPOSED TO CHILLING TEMPERATURES

Stock A (College Stock) vs. Stock B (Commercial Hatchery Stock)

Trial One

Temperature	Time Exposed Minutes	Lot Number	Stock	Number of Chicks	Mortality by Days														Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected	Ave. Wt. at 2 weeks
					1	2	3	4	5	6	7	8	9	10	11	12	13	14								
1°C	70	1	A	26															—	—	-	—	8	0	0.0	2.31
1°C	130	2	A	52	2	2					2	1							13.5	7	0	0.0	8	0	0.0	2.49
1°C	70	1	B	20					2	1	1	1		1			1		55.0	6	6	100.0	12	3	25.0	2.47
1°C	130	2	B	20	1				1								1		15.0	2	1	50.0	12	6	50.0	2.34

TABLE NO. XVIII

PER CENT MORTALITY and PER CENT INFECTION (BACT. PULLORUM) IN EXAMINED CHICKS

CHICKS EXPOSED TO CHILLING TEMPERATURES

Stock A (College Stock) vs. Stock B (Commercial Hatchery Stock)

Trial Two

Temperature	Time Exposed Minutes	Lot Number	Stock	Number of Chicks	Mortality by Days														Per Cent Mortality Chicks Examined (Died)	Number Infected	Per Cent Infected Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected	Ave. Wt. at 2 weeks
					1	2	3	4	5	6	7	8	9	10	11	12	13	14						
0°C	70	1	A	56	1	1			1		1		1						8.9	4	0	0.0	5	0	0.0	2.67
0°C	130	2	A	56	5*		1				3				1				17.9	5	0	0.0	5	0	0.0	2.44
0°C	70	1	B	21	1					2	1		1	2		1		2	47.6	9	7	77.8	8	5	62.5	2.27
0°C	130	2	B	21						1		2		1	1	2		4	52.4	9	6	66.7	8	4	50.0	2.32

* Died during exposure.

TABLE NO. XIX

PER CENT MORTALITY and PER CENT INFECTION (BACT. PULLORUM) IN EXAMINED CHICKS

CHICKS EXPOSED TO CHILLING TEMPERATURES

Stock A (College Stock) vs. Stock B (Commercial Hatchery Stock)

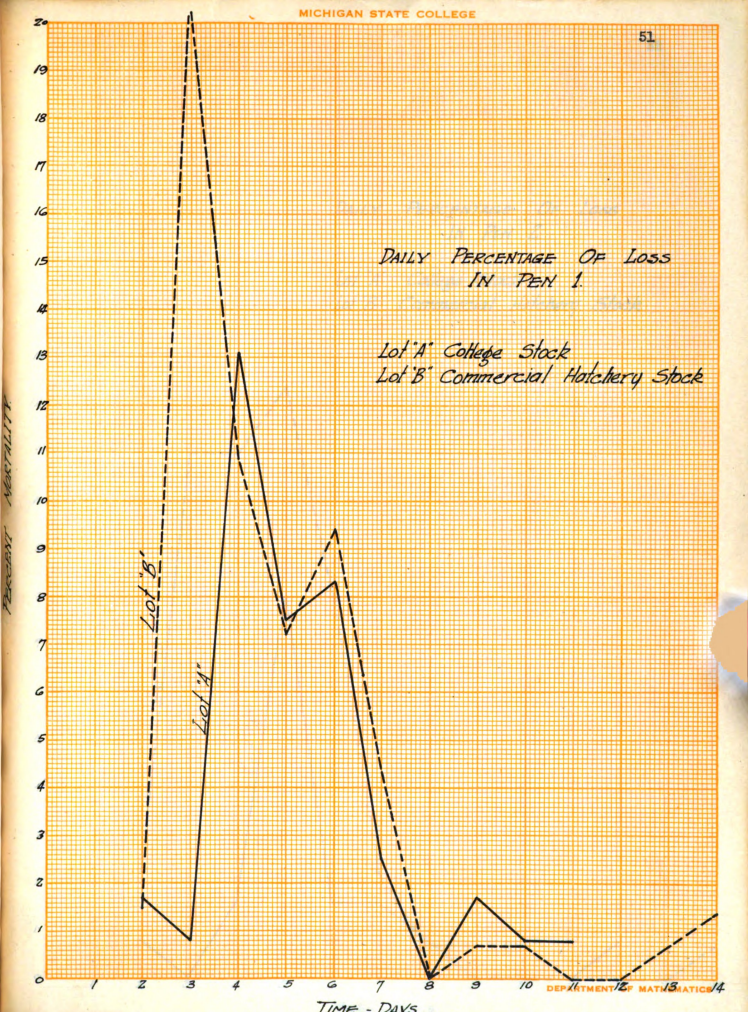
Trial Three

Temperature	Time Exposed Minutes	Lot Number	Stock	Number of Chicks	Mortality by Days														Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected	Ave. Wt. at 2 weeks
					1	2	3	4	5	6	7	8	9	10	11	12	13	14								
2°C	90	1	A	42	1	1	1			1									9.5	4	0	0.0	5	0	0.0	2.65
2°C	150	2	A	42		4			2										14.3	6	0	0.0	5	0	0.0	2.62
2°C	90	1	B	25								1							4.3	-	-	-	15	0	0.0	2.7
2°C	150	2	B	25																-	-	-	15	0	0.0	2.5

TABLE NO. XX

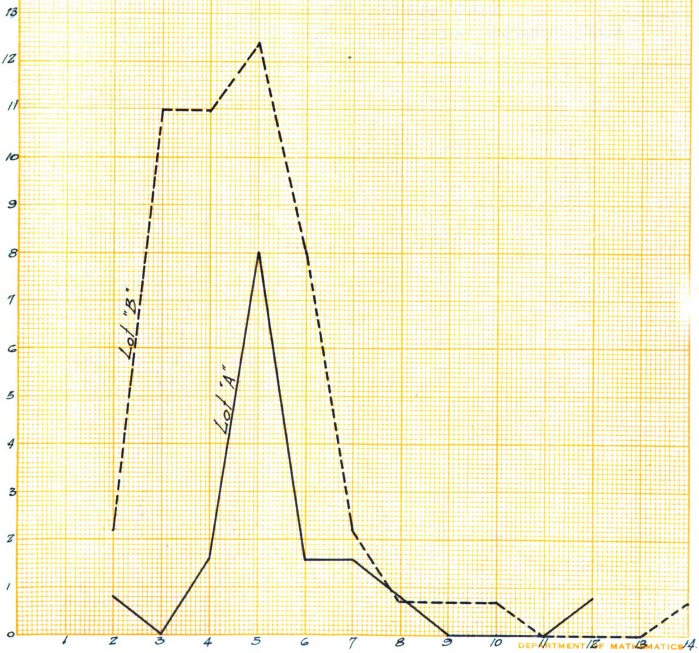
COMPARISON OF MORTALITY and PER CENT INFECTION (BACT. PULLORUM) OF EXAMINED CHICKS FROM STOCK B. STOCK B EXPOSED TO CHILLING TEM - PERATURES vs. STOCK B HELD AT 96° F. DURING FIRST WEEK

	Number of Chicks	Mortality in 2 weeks	Per Cent Mortality	Chicks Examined (Died)	Number Infected	Per Cent Infected	Chicks Examined (Killed at 2 weeks)	Number Infected	Per Cent Infected
Chilled	128	32	25	26	20	76.9	70	18	25.7
Held at 96°F.	137	44	32.1	39	32	82.1	59	18	30.5


DAILY PERCENTAGE OF LOSS
IN PEN 1.
Lot "A" College Stock
Lot "B" Commercial Hatchery Stock
Lot "B"
Lot "A"
PERCENT MORTALITY
TIME - DAYS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

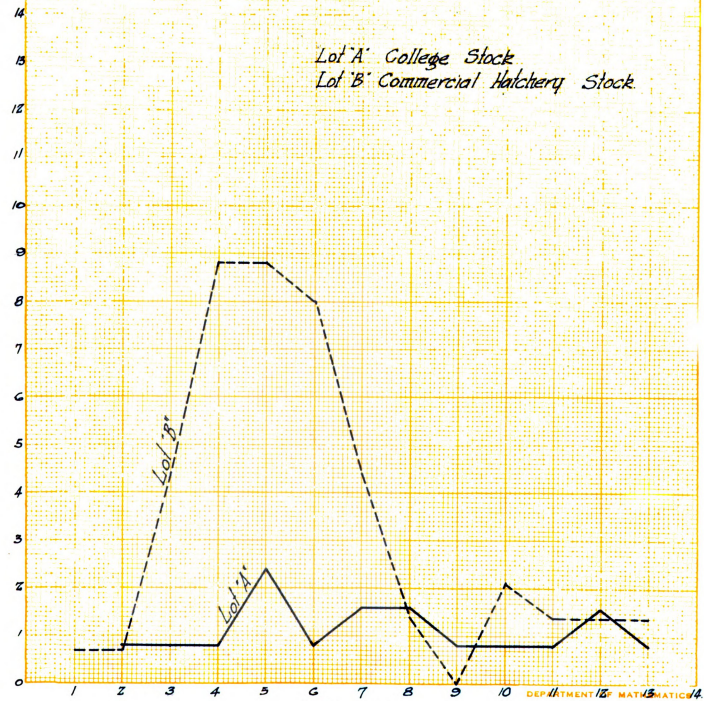
DAILY PERCENTAGE OF LOSS
IN PEN Z

Lot "A" College Stock
Lot "B" Commercial Hatchery Stock



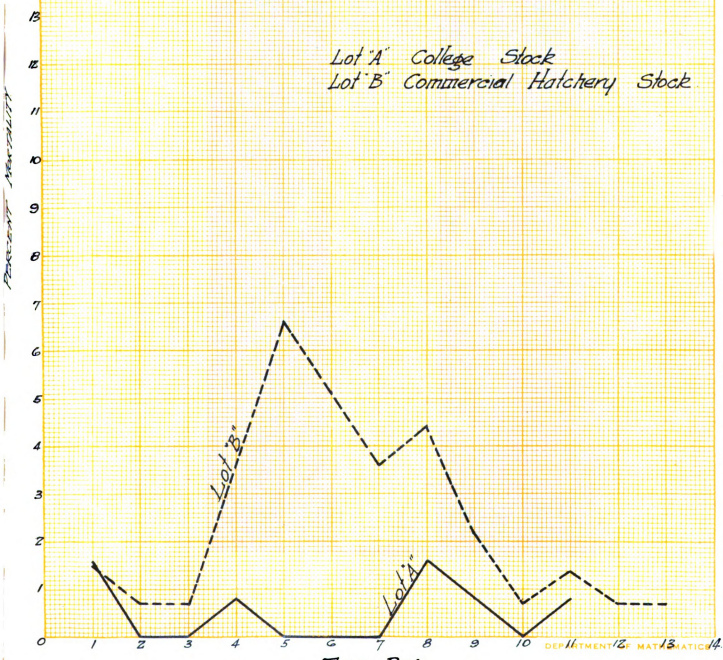
Daily Percentage Of Loss In Pen 3.

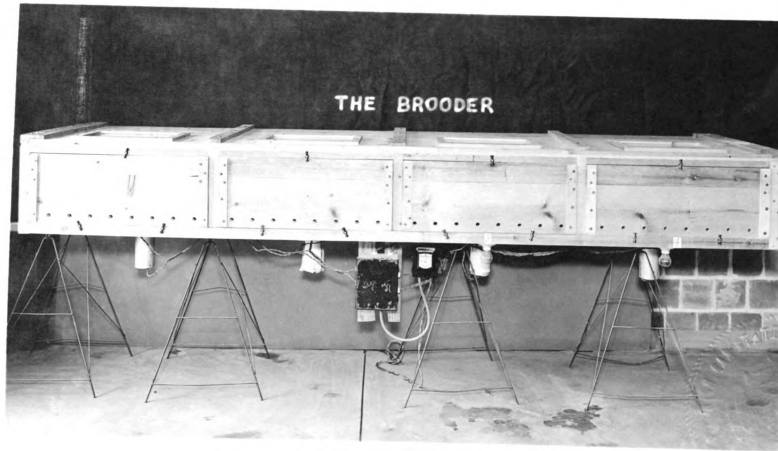
Lot 'A' College Stock
Lot 'B' Commercial Hatchery Stock

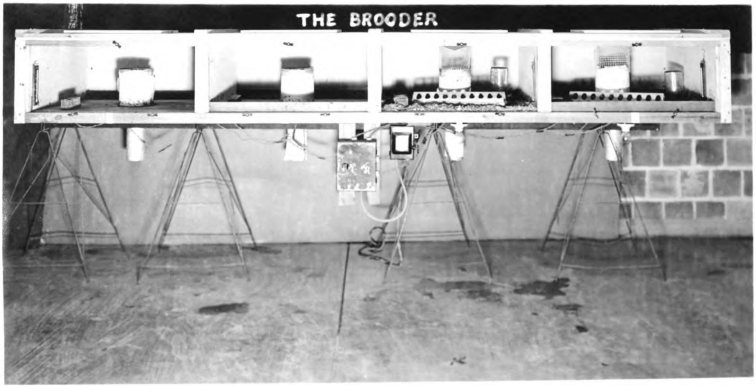


DAILY PERCENTAGE OF LOSS
IN PEN 4

Lot "A" College Stock
Lot "B" Commercial Hatchery Stock




THE BROODER


THE BROODER


Oct 22'36
May 5 '46
Aug 7 '46
Mar 19 '48

Pocket mss: 2 Suppl