STUDIES OF FIELD RESULTS OF TESTING FOR PULLORUM DISEASE

by

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INTRODUCTION

The usefulness of many biological tests is best judged by their practical application in diagnosing disease in the field, or in assisting in picking out infected animals in herds or flocks. In some instances special tests have been developed many years before they are put into field practice, to any extent, and even then their reliability, usefulness, and practibility in the field is often questioned. The expense of having them applied is often considered prohibitive by the live stock owner. To a certain extent this is the light in which flock owners and hatcherymen consider the testing of flocks for pullorum disease. This causes them to deviate from having the standard agglutination test methods applied to their flocks. They resort at the slightest provocation to cheaper, easier, or quicker methods, although the latter may not attain the desired end in eradicating the disease. The following study was taken up to determine if possible some of the advantages and disadvantages, the results either favorable or adverse, of testing flocks in the field

for pullorum disease.

REVIEW OF LITERATURE

Jones (1913) first showed that fowls carrying pullorum disease could be detected by means of the agglutination test and in 1914 Rettger, Kirkpatrick, and Jones called attention to the possibility that pullorum disease could be eradicated if united efforts were made and the agglutination test applied to all breeding stock of a state or given area. The next year they reported that a campaign had been started during June of the previous year looking toward the eradication of pullorum disease in Connecticut, and that it was based upon the results obtained with the use of the agglutination test. During the first year 107 flocks consisting of 13,837 birds were tested and 10.24 percent reactors were found. The reactors were removed and, later on, the same flocks were retested. At this time, four flocks out of 13 were free and the average percentage of infection in all the flocks lowered. The owners reported better breeding records and with few exceptions, showed a larger percent of livability of the chicks than the previous years.

This work was being continued from year to year and Jones (1924) reports that plans for testing 20,000 birds during that season were being made. The cost of testing at that time was $5.00 per farm, plus five cents for each bird tested.

Ward and Gallagher (1917) report field trials of the intradermal test as compared with the agglutination test. The birds were autopsied after testing, and showed lesions indicating the two tests were equally accurate. They reported no data that indicated the same conclusion on the livability of the chicks from these flocks.

Rettger, Kirkpatrick, and Card (1919) describe the testing of over 2,000 birds using the agglutination method. They found very few flocks of any size that were free from pullorum disease. In their opinion the greatest obstacle to permanent removal of all sources of infection from a flock by a single agglutination test is the condition of progressive infection from bird to bird. Maturing and adult hens are susceptible to infection from without. The spread in an adult flock may be very slow or stationary, or may spread to involve 20 to 25 percent of the entire

flock within 12 to 15 months.

Ward and Gallagher (1922) reported that for the detection of individual carriers among hens held for breeders, two methods had been developed, which give positive proof of the presence of infection in the flocks and pick out the infected individuals with a high degree of accuracy. These are the agglutination test first applied by Jones and the intradermal test developed by the authors.

Allen (1926) reported that during the last three years about 60,000 hens had been tested by the University laboratories. In this work the percentage of reactors in a given flock was reduced about one-half by the first years test when followed by removal of reactors. The retesting the second year followed again by removal of reactors was found to reduce the presence of the disease to a very low percentage or to completely eliminate it. Theoretically, the testing and removal of reactors should eliminate the disease completely and permanently but in practice such is not the case, due no doubt to the soil of chick yards, coops, brooders, and other uninvestigated factors which carry the disease germ to otherwise uncon-

taminated birds. Even sparrows and other birds may carry from one chick yard to another a certain amount of infection.

Hinshaw, Upp and Moore (1926) doing experimental work on the transmission of pullorum disease in incubators suggest a source of dissemination by means of the forced-air-draft type of machines not previously reported. The writers were not ready to make the assertion that pullorum disease could be spread in incubators naturally infected, but believed hatcherymen should be careful to prevent such dissemination by using hatching eggs from tested flocks only. The custom hatchery problem is one which needs more attention, and every precaution should be taken to insure the owners of custom-hatched chicks that their chicks are not being exposed to infection in the incubator. This can be done by insisting that clients buy eggs from tested flocks only, and by carefully cleaning and disinfecting incubators after each hatch. Custom eggs should not be hatched with eggs intended for commercial chicks, unless it is known that such eggs come from tested flocks.

Laird (1926) describes definite progress that

has been made in the control of pullorum disease in Illinois. The agglutination test was used. He states that the livability of chicks in tested flocks is the momentum that has made this project a success and that it is important we acknowledge the test is not 100 percent efficient but we no longer feel justified in condemning the test on its limitations.

Beaudette and Black (1927) showed that the annual testing of flocks reduces the percentage of infection found in them. In a few cases the percentage of infection actually increased but the authors believed that there was always a good reason for that, such as the introduction of infected stock, or poor sanitation. The question was frequently asked, "How many tests will be required to completely eliminate the infection from the flock". This depends upon several factors. Heavily infected flocks should require the longest time for eradication but this depends largely upon the management of the flock. A flock should be kept in quarters that can be thoroughly disinfected. The range flock offers a difficult problem, especially on general farms where good practices are not in vogue. These flocks are often on dirt floors and frequent places

which are never cleaned. Under such conditions, there is likely to be an increase in the degree of infection in spite of annual testing and the elimination of reactors. Under good management the disease may be eradicated from a very heavily infected flock in a short time.

Craig (1927) in reporting upon the control of pullorum disease in Indiana states that during the past two seasons veterinary practitioners have tested about 400,000 birds. Flocks tested reported to the State Department show 17 percent of the birds reacted to the first test and eight percent to the second test. Sixteen flocks that numbered about 3,000 birds had three annual tests, 20 percent reacted to the first, 13 percent to the second, and nine percent to the third tests respectively.

Tittsler, Heynang, and Charles (1928) in studying the control of pullorum disease concluded that it seemed to be definitely established that at present the only hope of control was through properly conducted and controlled agglutination testing of adult birds.

Edwards and Hull (1928) found that hens which gave a positive reaction are usually found to be un-

thrifty, low producing birds. In most instances they are unprofitable as egg producers. A flock of 200 birds under observation in the field was tested and 50 percent of them reacted. The reacting birds were placed in one pen and the non-reactors in another. The non-reactors laid twice as many eggs as the reactors. Chicks were hatched from the two flocks. The hatchability of the eggs from the non-reactors was much higher than the hatchability of the eggs from the reactors. A very high percentage of the chicks from the non-reactors survived while nearly all the chicks hatched from the eggs of the reactors died of pullorum disease.

Olney and Bederke (1928) related some field observations. One flock of 1,400 to 1,500 hens sustained increasing chick losses from 1924 to 1926 after which the flock was tested and all reactors removed. Of the eggs set 85 percent hatched through the season of 1927. This record shows 1,500 chicks hatched and a mortality of only five percent during the first four weeks. The authors do not wish to give the agglutination test credit for all of the improvement, for each year better methods of hatching and brooding chicks are used. The

exact amount of benefit derived from the test can be determined only by a series of well controlled experiments. They conclude that repeated yearly tests of breeding stock together with proper sanitation and a vigorous culling of unthrifty chicks will control the disease almost beyond question.

Craig (1928) found that during the previous season in Indiana, flock testing resulted in 20 percent of the birds in breeding flocks reacting to the first test, 12 percent to the second, and nine percent to the third. There were few flocks where no reactors were found. Most of the testing for pullorum disease was done where heavy losses of chicks had occurred. A veterinarian who tested about 20,000 birds during the hatching and breeding season reported a decided decrease in the number of reactors in flocks that were tested the preceeding year where the owners removed all reactors, and practiced sanitary measures as a part of their flock management.

The low mortality in chicks from tested flocks gives a better impression of the disease control work that the veterinarians are doing than does the percentage of reactors found in breeding flocks, that

have been tested for two successive seasons. The author also states that a large number of hatcherymen do not believe in testing breeding flocks for the purpose of controlling pullorum disease. This attitude is gradually being changed because of the growing demand for disease-free chicks. This is the most important factor in promoting disease-free flocks of high vitality and marked constitutional vigor which is the poultryman's description of the ideal breeding flock.

In a series of experiments Runnells (1929) showed that non-reacting hens laid enough more eggs than reactors to more than pay for testing and the percent of fertility and hatchability of non-infected hens was higher than that of infected hens. The death loss in chicks from infected flocks was approximately 25 percent greater than that in non-infected flocks, if the proper measures were taken to protect the chicks of the tested flocks from infection during incubation and brooding. In tabulating the results of four years testing work on 40 flocks in the field the author shows the percent of infection has been gradually decreased from as high as 21.3 percent infection to approximately four percent during that time.

Russell and Richardson (1929) report that the College of Agriculture, University of Maine, started making agglutination tests for the benefit of Maine poultrymen in August 1921. The laboratory work was done by the Department of Veterinary Science and Bacteriology, and the Extension Service carried on the educational program. Since that time, approximately 251,000 birds have been tested. When the test was started in 1921 the cost of testing was 15 cents per bird. This amount was necessary to cover the cost on the small number of birds which were tested at that time. Since then the cost has been reduced and in 1928 and 1929 the work was done for nine cents per bird. The policy has been to reduce the cost of testing to the absolute minimum. This amount covers the cost of taking the blood samples, the laboratory work, and the leg bands. These writers do not state what results are being obtained from this program of testing, but it is reasonable to suppose that good results follow this work or the poultrymen of Maine would not be willing to pay the price of the test.

Runnells (1929) writes that some poultrymen are of the opinion that reactions to the blood test are so

inconsistent that the test is unreliable as a means of diagnosing the disease. He, therefore, tested one lot of 14 hens four times and one lot of 13 hens three times and found that the blood of all but six of the 27 hens reacted quite consistently to the agglutination test. This discrepency was thought to be due to the test fluid and shows the test is not infallible. He concludes that it is the most practical means of detecting a high percent of the birds carrying infection.

Hinshaw, Sanders, and Dunlap (1929) in summarizing the control work done on pullorum disease from 1923 to 1929 show that the number of pullorum disease free flocks were increased from 38 to 228 during that interval of time. They indicate that up to the present time control measures rather than eradication of the disease have been emphasized, but that eradication of the disease would be emphasized in the future. They show that progress is being made in control and eradication by the increase in number of entire flocks being tested annually, by the reduction of percentage of infection in flocks tested for one or more consecutive years and that yearly or more frequent testing of the entire flock reduces the percentage of infection rapidly.

Simms (1929) describes the method of conducting the first years field tests for pullorum disease in Oregon and states that from the number of tests called for by the poultrymen the following season, that it seems proof that they have been fairly well satisfied with the work.

Wilson (1929) in summarizing the results of the control of pullorum disease in the field in Virginia, states that after the hatching season was over last spring, a circular letter was sent to all flock owners who had their flocks tested. Replies indicated that in the judgment of the flock owners the general health and egg production of their flocks had been improved, the livability of the chicks increased and the hatchability of the eggs bettered. The ultimate aim should be disease-free flocks and these can be obtained by making two or three tests at thirty day intervals and using proper sanitary precautions to prevent reinfection.

Rettger (1929) in speaking of the field efficiency of pullorum disease control and eradication indicates that it is a practical and feasible thing, and that the adoption sooner or later of a definite, standardized, and scientifically and reliably operated system

of control based upon accepted tests will be found quite generally to be the real solution of the pullorum disease problem.

Bunyea and Hall (1929) indicate there is a real need for the development of a reliable field test which might be placed in the hands of authorized and properly trained men as a part of a nationally organized plan of area eradication of pullorum disease. In studying the known methods of field diagnosis, none were found quite suitable for use. Experiments were conducted using fresh whole blood instead of separated serum in making agglutination tests. The antigen used for this simplified agglutination test consisted of a very turbid suspension. They report that in a limited amount of field work they have found this method to check quite closely with the tube method, and enumerate some of its possible advantages in area eradication work. They concluded that until further tests have been made and the reliability of the simplified method established beyond doubt, practical poultrymen should not discard methods of proven value.

TECHNIQUE IN OBTAINING INFORMATION

In obtaining information upon the incidence of pullorum disease and the field results obtained in raising chicks from tested flocks, the following measures were used: (1) Farm visits to flocks of sick chicks, (2) Reports by county agents and veterinarians of flocks of sick chicks, (3) Reports direct from flock owners, (4) Diagnosis made by the Department of Bacteriology, Kansas State Agricultural College, (5) Questionnaires sent direct to flock owners, (6) Questionnaires sent to hatchery operators, (7) Visits to hatcheries, (8) Visits and check up on tested flocks, (9) Visits to and reports from tested flock owners where trouble followed in chicks.

TABULATIONS AND DISCUSSION

A study of pullorum disease was made in the field and the results of the use of the agglutination test were observed in the control and eradication of this disease over a period of three years. During the year 1926, a small number of flock owners who had sustained severe chick losses during the preceding

chick season were pursuaded to have their flocks tested and were asked to keep a record of the eggs set, chicks hatched, and chicks that died within the first three weeks and to report any serious trouble at once.

The Department of Bacteriology at the Kansas State Agricultural College wished to acquire more experimental data on pullorum disease, so was willing to furnish vials for, and do all the testing of blood samples. Flock owners were to have their flocks bled and the samples sent to the laboratory. They were requested to fill out an application form which gave a brief history of their flock. It was suggested that they should continue to test their flocks for a period of at least five years. At the time the application forms were made out the flock owner was given an outlined plan of the various sanitary measures to use in handling his flock to assist in controlling and eradicating pullorum disease.

The results of the first years work were so encouraging to the flock owners that the two following seasons the number of those who wished to have this work done was almost doubled each season. In making the second and third year studies the same general

plan of procedure was followed and a few new items of investigation were added to the original list. At the end of the first year, the Department of Bacteriology found it impractical to continue to do the field testing so this work was turned over to accredited veterinarians, who made all of the tests included in this study, except of the hatchery flocks in one county. When a flock was tested the owner was expected to remove reactors within seven days and he was advised regarding sanitary procedures to follow. At this time, the breed, number of birds in the flock, and the number of reactors found were tabulated. When each hatching season was over, a questionnaire was sent out to each flock owner asking him definite questions as to the results for the brooding season.

All this work was voluntary on the part of the flock owner as no rules or regulations could be laid down or enforced, and our recommendations or suggestions could be ignored or adopted at will. An effort was made to visit and give particular attention to those flock owners having trouble and a definite cause determined, although this could not be done in all cases.

Table I. Results from flocks tested season 1926-27

Flock number	Tested	Reactors	Percent reactors	Number eggs set	Number hatched	Percent hatched	Died within 3 wks.	Percent died in 3 wks.
1	152	60	39.4	1,000	750	75.0	45	6.0
2	106	1	0.9	530	310	58.4	19	6.1
3	180	89	49.4	540	405	75.0	5	1.2
4	64	24	37.5	260	175	67.3	25	14.2
5	177	88	49.7	1,070	615	57.4	300	48.7
6	301	14	4.9	--	-	--	-	--
7	172	21	12.2	--	*753	--	13	1.7
8	227	6	2.6	4,500	3,600	80.0	180	5.0
9	98	9	9.2	--	*350	--	2	0.5
10	65	34	63.0	600	360	60.0	3	0.8
11	97	21	21.6	1,150	832	72.3	20	2.4
12	116	43	37.1	2,131	1,231	57.7	200	16.2
13	245	19	7.7	2,700	1,400	51.8	300	21.4
14	50	5	10.0	--	*192	--	10	5.2
15	261	35	13.4	3,500	2,600	74.2	257	9.8
16	40	13	32.5	338	240	70.0	13	5.4
17	115	39	33.9	--	--	--	-	--
18	59	3	5.0	490	240	48.9	15	6.2
19	112	63	50.8	--	--	--	-	--
20	35	7	20.0	290	119	41.0	-	--
21	23	5	21.7	--	--	--	-	--
Totals	2,695	599	22.2	19,099	12,877	67.4	1,407	10.9

*Omitted from totals

This work was started in five counties. Table I shows that 21 flocks comprising a total of 2,695 birds were tested during the season of 1926 and 1927. As it happened all of these flocks were infected. A total of 599 reacting birds were found. The maximum amount of infection in any flock was 63 percent and the minimum 0.9 percent. This shows an infection in these flocks of 22.22 percent. No record could be obtained on the productivity of the flocks, except in a few instances. It was known that flocks No . 2, No. 6, and No. 8 were good producers and that flocksNo. 11 and No. 15 were fair producers. All of these flock owners hatched their own eggs. The number of eggs incubated was 19,099. The number of chicks hatched was 12,877. The percent of hatchability was 67.4 percent or a little better than average. In other words, as far as these records show, their is only a slight increase of hatchability that can be in any way connected up with the testing. The total number of chicks that died within the first three weeks after hatching was 1,407. This shows a loss of 10.9 percent during the period of time when pullorum disease usually takes its toll.

It will be seen that flocks No. 5, No. 12, and No. 13 sustained the majority of the chick losses. In

checking up on these losses it was found that the reactor birds had not been sold from flock No. 5, that the brooder house partly burned down on flock No. 12, and that a brooder stove failed during cold weather with flock No. 13. One case of mismanagement and two unavoidable accidents. Excluding these three flocks, the death rate of the other 18 flocks within the first three weeks was 6.3 percent.

In checking up on the attitude of the flock owners regarding the years results of testing work, it was found that 19 were well satisfied that it had paid them to have their flocks tested. Two were not. The results in livability of chicks from these flocks previous to testing had been investigated and it was found that chicks from at least six of these flocks had suffered high mortality ranging in some instances from 50 to 90 percent. In fact some flock owners had stopped selling eggs for hatching purposes, because the chicks hatched from them all died.

Table II. Results from flocks tested season 1927-28

Flock number	2 Eggs set before test	3 Hatched before test	Percent chicks hatched	4 Chicks died before 3 wks	Percent died before 3 wks	5 Number birds tested	6 Number reactors	Percent reactors	7 Eggs set after test	8 Chicks hatched	Percent hatched	9 Chicks died before 3 wks	Percent died before 3 wks	10 Better results
1	0	0	-	0	0	208	55	26.4	1,500	825	55.0	0	0.0	+
2	0	0	-	0	0	228	17	7.4	1,920	980	51.0	430	43.8	-
3	0	0	-	0	0	116	5	4.3	1,083	735	67.8	123	16.7	+
4	0	0	-	0	0	65	9	13.8	315	250	79.3	0	0.0	+
5	0	0	-	0	0	106	18	16.9	700	451	64.4	52	11.3	+
6	0	0	-	0	0	0	0	0.0	725	500	68.9	50	10.0	+
7	0	0	-	0	0	137	10	7.2	425	265	62.3	5	1.8	+
8	0	0	-	0	0	217	12	5.5	2,500	2,000	80.0	0	0.0	+
9	118	77	65.2	25	32.4	147	32	21.7	4,107	3,214	78.2	152	4.7	+
10	0	0	-	0	0	73	35	47.9	510	340	66.6	170	50.0	-
11	0	0	-	0	0	267	4	1.4	2,640	1,963	74.3	0	0.0	-
12	0	0	-	0	0	160	50	31.2	1,080	650	60.1	325	50.0	-
13	0	0	-	0	0	108	6	5.5	800	440	55.5	200	45.4	-
14	180	110	61.1	10	9.0	137	29	21.1	240	180	75.0	27	15.0	?
15	0	0	-	0	0	150	52	34.6	980	550	56.1	45	8.1	+
16	0	0	-	0	0	125	20	16.0	600	375	62.5	20	5.3	+
17	0	0	-	0	0	122	14	11.4	1,200	712	59.3	274	38.4	+
18	0	0	-	0	0	432	23	5.3	1,700	1,051	61.8	81	7.7	+
19	0	0	-	0	0	460	31	6.7	1,400	1,100	78.5	0	0.0	+
20	0	0	-	0	0	170	28	16.4	1,800	1,060	58.8	45	4.2	+
21	0	0	-	0	0	200	47	23.5	1,400	1,000	71.4	200	20.0	+
22	0	0	-	0	0	114	3	2.6	988	603	61.0	48	7.9	+
23	160	125	78.1	20	16.0	159	16	10.0	350	285	81.4	20	7.0	+
24	0	0	-	0	0	133	30	22.5	450	329	73.1	8	2.4	+
25	0	0	-	0	0	246	64	26.0	1,800	1,440	80.0	360	25.0	+
26	0	0	-	0	0	107	49	45.7	575	400	69.5	200	50.0	+
27	0	0	-	0	0	277	4	1.4	970	808	83.2	12	1.4	+
28	0	0	-	0	0	16	0	0	50	30	60.0	0	0.0	+
29	0	0	-	0	0	108	3	2.7	600	475	79.1	5	1.0	+
30	0	0	-	0	0	128	16	12.5	750	500	66.6	10	2.0	+
31	0	0	-	0	0	270	11	4.0	1,500	1,000	66.6	25	2.5	+
32	0	0	-	0	0	364	63	17.3	1,200	750	62.5	40	5.3	+
33	0	0	-	0	0	250	15	6.0	2,000	1,600	80.0	0	0.0	+
34	0	0	-	0	0	140	42	30.0	750	500	66.6	21	4.2	+
35	0	0	-	0	0	167	33	19.7	474	332	70.0	49	14.7	+
36	0	0	-	0	0	53	20	37.7	175	140	80.0	25	17.8	+
37	0	0	-	0	0	126	7	5.5	560	371	66.2	16	4.3	+
38	0	0	-	0	0	114	67	58.7	215	133	61.8	10	7.5	+
39	0	0	-	0	0	98	21	21.4	375	140	37.3	0	0.0	+
40	620	425	68.5	361	84.9	34	16	47.0	300	230	76.6	20	8.6	+
41	0	0	-	0	0	81	18	22.2	740	532	71.8	80	15.0	+
42	0	0	-	0	0	147	36	24.4	75	69	92.0	2	2.8	+
43	0	0	-	0	0	169	12	7.1	9,000	6,000	66.6	162	2.7	+
Totals	1,078	737	68.3	416	56.4	6,929	1,043	15.0	51,522	35,308	68.5	3,312	9.3	1 ? 5 - 37 +

? Not known.
- No.
+ Yes.

Table II gives the results obtained on the second year's tests. Although a greater number of flocks were tested on account of the increased demand for the work, complete records could be obtained from 43 only, in four counties distributed from the western to the eastern part of the state. It may be noted that one county which started in this work the previous year was dropped as all the flocks in that county were being tested by a hatcheryman.

It will be seen that flocks No. 9, No. 14, No. 23, and No. 40 had a total of 1,078 eggs set from them before testing. From these eggs, 737 chicks were hatched, showing a hatchability of 68.3 percent. This is a high percent of hatchability. Four hundred sixteen of these chicks died before three weeks of age, which gives a 56.4 percent mortality on these chicks from untested flocks. It will be seen that there was a total of 6,929 birds tested in which 1,043 reactors were found. This shows 15 percent infection against 22.2 percent in the 21 flocks of the previous year. Some of this reduction in percentage of infection was undoubtedly due to a number of the flocks having been tested the previous year, as there was only one free flock found in the 43 tested and it was a very small one of 16 birds.

It will be noted that the range of percent of infection during this season was very similar to the previous one, the maximum being 58.7 percent and the minimum zero. After these flocks were tested a total of 51,522 eggs were set, from which 35,308 chicks were hatched, showing a 68.5 percent hatchability. It will be noted that this percent of hatchability of the eggs set after testing from all of these flocks is practically the same as that from four of the flocks before testing. But, if the percent of hatchability of the four flocks only be considered before and after testing, it will be seen that before testing they showed 68.3 percent, whereas after testing they showed 78.2 percent, or an increase of 9.9 percent. Some other factors may have been responsible for this increase in hatchability. A total of 3,312 chicks died during the first three weeks from all causes, which time covers the period of acute pullorum disease in chick flocks. The loss was 0.3 percent as compared with the loss of 56.4 percent in the chicks hatched before testing.

Outstanding losses were sustained in flocks No. 2, No. 10, No. 12, No. 13, No. 17, No. 25 and No. 26. If

these flocks were not counted the mortality of the chicks in the remaining 36 flocks would be only 4.45 percent which is a reduction of more than half. In analyzing the adverse results sustained in these seven flocks, the following was learned.

On flock No. 2, the test was made properly, the reactors removed, the eggs incubated separately, and the brooding and feeding conditions fairly good. Three bunches of chicks from different hatches were sent to the Bacteriology Department, Kansas State Agricultural College, and a definite diagnosis of pullorum disease was obtained each time. The infection appeared to be carried over from the mature flock, although only 7.4 percent of reactors were taken out by test that season. The reason for this was not determined.

A report from flock No. 10 was sent in which stated that the chicks were dying with pullorum disease. A visit was made to this flock. It was found that the chicks were between five and six weeks old before death losses began, and that the chicks were dying of avitaminosis A.

The eggs of flock No. 12 were custom-hatched with eggs from untested flocks and the chicks were undoubt-

edly infected with pullorum disease at hatching time.

No report could be obtained on flock No. 13 and no visit could be made.

The eggs from flock No. 17 were custom-hatched, the chicks becoming infected at hatching time from chicks from untested eggs.

Although flock No. 25 lost 25 percent of the chicks, the owner was well satisfied as a 50 percent death loss had been sustained for a number of years previous. Brooding and management were poor.

In investigating the losses in flock No. 26, it was found that half of the chicks were custom-hatched and these were brooded together with home hatched chicks. Apparently infection was spread through the incubator.

From the above history of these cases, the field investigations show that only in one instance could the disease be traced directly back to the infected flock after testing.

A tabulation of the reports on the results as stated by the flock owners shows that 37 state better results were obtained than before testing, five report no better results, and one is in doubt. Of these five

bad reports, flocks No. 2, No. 10, No. 12, and No. 13 have already been described. Flock No. 11 lost no chicks and reports no better results than previously obtained. It will be noted there was only 1.4 percent infection in this flock on initial test. The report of flock No. 26 shows that 50 percent of the chicks died. This loss was less than that reported on previous years and for this reason, the owner considered that the testing was of benefit in spite of the heavy losses.

Table III. Results from flocks tested season 1928-29.

Flock number	2 Eggs set before test	3 Hatched before test	Percent chicks hatched	4 Chicks died before 3 wks	Percent died before 3 wks	5 Number birds tested	6 Number reactors	Percent reactors	7 Eggs set after test	8 Chicks hatched	Percent hatched	9 Chicks died before 3 wks	Percent died before 3 wks	10 Better results	11 Mixed eggs	12 Name of incubator
1	0	0		0		233	65	27.9	900	539	59.8	50	9.2	+	?	b
2	0	0		0		117	42	35.9	400	164	41.0	7	4.2	+	?	s
3	0	0		0		108	0	0.0	1,030	746	72.4	8	1.0	+	-	b
4	0	0		0		97	1	1.0	426	270	63.3	10	3.7	+	-	n
5	0	0		0		160	30	18.7	1,522	830	54.5	125	15.0	+	-	q, o
6	0	0		0		132	0		1,000	500	50.0			+	-	b
7	0	0		0		139	41	29.5	980	395	40.3	100	25.3	-	-	su
8	0	0		0		92	12	13.0	500	414	82.8			+	-	h
9	0	0		0		126	33	26.1	2,900	1,400	48.2	140	10.0	+	-	?
10	0	0		0		445	26	5.8	987	629	63.7	10	1.5	+	+	b
11	0	0		0		226	0		650	229	35.2	4	1.7	-	-	q, o
12	0	0		0		161	11	6.8	596	368	61.7	9	2.4	+	-	q, f
13	0	0		0		255	51	20.0	800	*641	80.1	80	12.4	+	?	n, s
14	0	0		0		158	22	13.9		*100		7	7.0	+	?	?
15	0	0		0		181	80	44.2	136	950		180	18.9	+	+	?
16	0	0		0		89	0		279	166	59.5	4	2.4	+	-	sh
17	0	0		0		128	28	21.8	750	400	53.3	150	37.5	+	-	f
18	0	0		0		42	10	23.8	140	72	51.4	5	66.9	+	+	sa
19	0	0		0		174	17	9.7	1,200	895	74.5	81	9.0	+	-	f
20	0	0		0		309	68	22.0	1,800	820	45.5	70	8.5	+	-	bc, f, O
21	0	0		0		208	7	3.3	612	358	58.5	10	2.7	+	-	?
22	0	0		0		210	48	22.8	480	351	73.1	11	3.1	+	-	b
23	0	0		0		155	28	18.0	900	500	55.5	5	1.0	+	-	sr
24	0	0		0		138	3	2.1	450	200	44.4	4	2.0	-	-	j
25	1,800	1,125	62.5	135	12.0	247	24	9.7	1,600	1,265	79.0	37	2.9	+	-	bo, c, su
26	0	0		0		59	23	38.9	165	130	78.7	50	38.4	+	-	b
27	0	0		0		300	11	3.6		*200		16	8.0	+	+	?
28	0	0		0		362	52	14.3	900	616	68.4	6	0.9	+	-	sa, sr
29	0	0		0		191	40	20.9	1,130	603	53.3	46	7.6	+	-	f
30	0	0		0		194	20	10.3	550	423	76.9	24	5.6	+	+	?
31	0	0		0		132	15	11.3	900	562	62.4	7	1.2	+	-	q, n
32	0	0		0		125	25	20.0	680	400	58.8	11	2.7	+	-	b
33	0	0		0		212	0		200	150	75.0	2	1.3	+	-	h
34	0	0		0		169	24	14.2	465	351	75.4	56	15.9	+	+	b
35	0	0		0		462	17	3.6	1,651	1,320	79.9	21	1.5	+	-	k, w
36	0	0		0		254	7	2.7	336	288	85.7	0	0.0	+	-	b
37	175	125	71.4	50	40.0	130	51	39.2	350	275	78.5	20	7.2	+	-	o
38	0	0		0		221	47	21.2	1,440	655	45.4	275	41.9	-	-	b, f
39	0	0		0		174	16	9.2	600	400	66.6	10	2.5	+	-	b
40	0	0		0		233	0		700	525	75.0	5	0.9	+	-	b
41	0	0		0		66	10	15.1	426	327	76.7	25	7.6	+	-	?
42	0	0		0		305	61	20.0	768	510	66.4	28	5.4	+	+	?
43	0	0		0		300	14	4.6	5,000	2,000	40.0	1,000	50.0	-	-	q
44	0	0		0		102	0		500	277	55.4	48	17.3	-	?	?
45	0	0		0		175	10	5.7	930	700	75.2	30	4.2	+	-	nf
46	0	0		0		900	60	6.6	2,670	2,000	74.9	50	2.5	+	-	b
47	0	0		0		176	0		1,200	615	51.2	148	24.0	+	-	q, b
48	90	50	55.5	46	92.0	160	10	6.2	360	290	80.5	9	3.1	+	?	?
49	0	0		0		125	16	12.8	1,000	650	65.0	40	6.1	+	-	b
50	0	0		0		186	19	10.2	1,000	700	70.0	100	14.2	+	-	o
51	641	175	27.3	30	17.1	146	34	23.2	1,075	534	49.6	84	15.7	-	+	m, s
52	0	0		0		169	13	7.6	540	334	61.8	7	2.1	+	+	?
53	0	0		0		143	10	6.9	2,600	1,300	50.0	68	5.2	+	-	q, f
54	0	0		0	0	50	2	4.0	200	70	35.0	2	2.8	+	-	h
55	0	0		0	0	195	6	3.0	2,040	745	36.5	93	12.4	-	-	sr, f
56	0	0		0	0	168	8	4.7	650	270	41.5	10	3.7	+	-	sr, bc, d
57	800	177	22.1	30	16.9	145	35	24.1	600	200	33.3	25	12.5	-	-	q
58	0	0		0		65	0		600	240	40.0	9	3.7	+	-	b
59	0	0		0		260	2	0.7	1,400	796	56.8	50	6.2	+	+	s, m
60	0	0		0		194	38	19.5	1,050	715	68.1	77	10.7	+	?	c, f, bc
61	0	0		0		295	57	19.4	2,500	1,750	70.0	17	0.9	+	-	b
62	50	47	94.0	4	8.5	80	2	2.5	150	130	86.6	2	1.5	+	-	h
63	300	220	73.3	118	53.6	170	50	29.4	635	449	71.8	10	2.2	+	-	su, b
64	0	0		0		112	25	22.3	2,250	1,470	65.3	376	25.5	+	-	b
65	1,080	579	53.6	17	2.9	142	12	8.4	4,972	2,872	57.7	86	2.9	+	-	j
66	0	0		0		323	6	1.8	765	490	64.0	60	12.2	+	-	bc, o
67	0	0		0		119	2	1.6	910	613	67.3	80	13.0	+	+	bc, sa
68	0	0		0		344	15	6.1	1,540	1,060	68.8	53	5.0	+	?	?
69	0	0		0		271	53	19.5	450	342	76.0	1	0.2	+	-	f, sh
70	0	0		0		96	10	10.4	900	550	61.1	25	4.5	+	-	su, sa, bc
71	0	0		0		526	0		1,440	1,125	78.1			+	-	b
72	0	0		0		263	4	1.5	748	705	94.2	16	2.2	+	-	o
73	0	0		0		127	12	9.4	480	352	73.3	31	8.8	+	?	?
74	0	0		0		110	43	39.0	1,000	600	60.0	25	4.1	+	-	sa
75	0	0		0		543	0		1,000	745	74.5	9	1.2	+	-	a
76	0	0		0		19	1	5.2	50	30	60.0	9	30.0	+	-	h
77	0	0		0		174	47	27.0	1,348	710	52.6	394	55.4	-	?	?
78	0	0		0		92	7	7.5	210	127	60.4	2	1.5	+	-	h
79	0	0		0		104	45	43.2	280	229	81.7	2	0.8	+	-	g
80	0	0		0		455	18	3.9	1,624	1,037	63.8	18	1.7	+	-	g, d, nf
81	0	0		0		142	10	7.0	450	358	79.5	15	4.1	+	?	?
82	0	0		0		265	7	2.6	1,000	584	58.4	32	5.4	+	-	a
83	0	0		0		248	11	4.4	608	462	75.9	0	0.0	-	-	sr, o
84	0	0		0		125	2	1.6	650	470	72.3	3	0.6	+	-	sr, bc
Totals	4,936	2,498	50.6	430	17.2	16,421	1,782	10.8	81,664	50,333	61.6	4,825	9.5	73 + 11 - 0 ?	11 + 62 - 11 ?	

* Omitted from totals.
? Not known.
\- No.
\+ Yes.
a Automatic.
b Buckeye.
bc Belle City.
bo Bohn.
c Cypress.
d Dependable.
f Favorite.
g Gem City.
h Hens.
j Jamesway.
m Mammoth.
n Newton.
nf Never Fail.
o Old Trusty.
p Prairie State.
q Queen.
s Smith.
sa Safety Match.
sh Super Match.
sr Sure Match.
su Successful.
w Wisconsin.

Table III shows the field studies of testing work done during the season of 1928-1929. Eighty-four flocks are included in this seasons work. It will be seen that eight flock owners set a total of 4,936 eggs before having their flocks tested. From these eggs, 2,498 chicks were hatched. This shows a hatchability of 50.6 percent. Of these chicks, 430 died within the first three weeks, the loss was 17.2 percent. It will be noted that one of the smallest flocks lost 92 percent, whereas one of the largest flocks only lost 2.94 percent of the chicks before testing the flock.

There was a total of 16,421 birds tested of which 1,782 were found to be reactors. This shows 10.8 percent reactors against 15 percent the previous season and a 22.2 percent for the first years tests. It is apparent that repeated testing had its effect.

Comparing the results of those flocks which hatched chicks before and after testing, it will be seen that the percent of hatchability of the totals of these flocks before testing was 50.6 percent and of the same eight flocks after testing it was 59.1 percent. The mortality of the chicks within three weeks after hatching was 17.2 percent from untested flocks whereas it was 4.7 percent from tested flocks.

There were 81,644 eggs set from these 84 flocks, from which 50,333 chicks were hatched. The percent of hatchability was 61.6 percent as compared with 68.5 percent for the previous season and 67.4 percent for the 1926 season. A total of 4,825 chicks died within three weeks, making a death loss of 9.5 percent for the 84 flocks.

It will be noted that nine flocks show a chick mortality of over 25 percent. In all but two of these flocks, the percent of reacting birds removed ranged between 20 and 30 percent.

In checking up on these high mortality flocks, it was found in flock No. 7 that the reactors have not been removed consistently. Occasionally good producers or higher priced reactors being kept.

The high mortality in flock No. 17 was the result of one lot of chicks being brooded with hens in a cold unventilated building. All chicks artificially brooded from the same hatch did well. The owner was well pleased with the results after testing in spite of the losses with hens.

Flock No. 18 lost 66.94 percent of the chicks. It was impossible to visit or get any data on the

cause of mortality. The owner reports that she feels she has had better results than previous to testing. Just why was not stated.

Flock No. 26 sustained a high mortality, the eggs being custom hatched with eggs from non-tested flocks.

In flock No. 38, the high mortality was reported to be due to brooder house troubles, as all who bought chicks from this flock raised almost 100 percent. No post-mortem or laboratory examinations could be made on these chicks. Some pullorum disease may have been present.

The reasons for the 50 percent death loss in flock No. 43 are unknown. It was not possible to visit this flock.

In flock No. 64, poor brooding methods were reported as being responsible for the losses. The owner stated that better results were obtained after testing than before. There is also a possibility that some infection carried over from the parent stock.

Some of the chicks of flock No. 76 were custom-hatched. This probably resulted in an infection of the flock.

All of chicks in flock No. 77 were custom-hatched

with eggs from untested flocks.

In summing up these bad results, it is probable that pullorum infection was present in at least two flocks. Unfortunately, a laboratory examination was not made of the other cases.

In questioning the flock owners as to whether they thought they had obtained better results after testing than in previous years, 73 stated that they did and 11 that they did not. Four of these eleven flocks are No. 7, No. 38, No. 43, and No. 77, the troubles of which were previously described. Three flocks, No. 11, No. 24, and No. 83 had had excellent results previous to testing and the other four flocks No. 44, No. 51, No. 55, and No. 57, sustained a loss after testing varying from 12 to 17 percent. It is interesting to note that only one of these 11 flocks, No. 51, reports the hatching of eggs from tested and untested flocks in the same incubator.

In Table III, under the heading "Mixed eggs", are listed those flock owners who reported that they had or had not, mixed or hatched eggs from untested flocks with those of tested flocks in the same incubator. Sixty-two report that they had not hatched their chicks

in incubators with eggs from untested flocks. Eleven report this had been done, and 11 reported that they did not know.

Twenty-one different kinds of incubators were used by these 84 flock owners. Fifteen flock owners did not know what kind of incubators were used in hatching their chicks. Eight used hens for hatching purposes. Of the nine flock owners reporting high mortality, it is interesting to note that two used incubators of the forced-air-draft-type; one used machines of both types; four used still-air incubators; one used hens; and one did not report the method of incubation.

Table IV. Results from flocks tested for three years

Flock number	Years tested	County	Breed	Number birds tested	Reactors	Percent reactors	Number eggs set	Hatched	Percent hatched	Number died within 3 wks.	Percent died within 3 wks.
I	First	Ness	S.C.R.I.R*	59	3	5.0	490	240	48.7	15	6.2
	Second	"	"	116	5	4.3	1,083	735	67.8	3	0.4
	Third	"	"	132	15	11.3	900	562	62.4	7	1.2
II	First	"	"	40	13	32.5	338	240	71.0	13	5.4
	Second	"	"	65	9	13.8	315	250	79.3	none	0.0
	Third	"	"	92	12	13.1	500	414	82.8	none	0.0
III	First	"	"	112	63	50.8	500	403	80.6	37	9.1
	Second	"	"	106	18	17.9	700	451	64.4	52	11.5
	Third	"	"	160	30	18.7	1,522	830	54.5	125	15.0
IV	First	Lyon	"	97	21	21.6	1,150	832	72.3	20	2.4
	Second	"	"	137	10	7.2	425	265	62.3	5	1.8
	Third	"	"	108	0	0.0	1,030	746	72.4	8	1.0
V	First	"	"	98	9	9.2	420	350	83.3	2	0.5
	Second	"	"	217	12	5.5	2,500	2,000	80.0	none	0.0
	Third	"	"	153	4	2.6	1,000	799	79.9	12	1.5
VI											
VI	First	Clay	W. Wynd.**	152	60	39.4	1,000	750	75.0	5	6.0
	Second	"	"	203	55	26.4	1,500	795	53.0	none	0.0
	Third	"	"	139	42	29.4	980	395	40.3	100	25.3
VII	First	"	"	180	89	49.4	540	405	75.0	5	1.2
	Second	"	"	271	17	7.4	1,920	980	51.0	430	43.8
	Third	"	"	189	15	7.7	1,900	1,000	52.6	175	17.5
Totals				2,826	502	17.7	20,713	13,442	64.8	1,054	7.8

* Single Comb Rhode Island Red
** White Wyndotte

Table IV shows the results of testing a limited number of flocks once each year over a period of three years, and gives their chick records for the same period. The number of flocks is small. Although many more started in the work, only these few carried out all the details for the three year period. There were 502 reactors in a total of 2,826 birds tested. It will be seen that all the flocks were found quite heavily infected upon the first test. The highest percent of infection was 50.8 and the lowest five percent on initial tests. Over the three year period, a total of 20,713 eggs were set from which 13,442 chicks were hatched. The hatchability covering this period was 64.89 percent, which is slightly below what is shown in other tables on flocks tested a smaller number of times. The percentage of mortality of the chicks is quite low for the three year period, being only 7.84 percent. If the trouble in one flock, which proved positively to be a carry over of pullorum disease, could have been eliminated, the percent of chicks that lived would have been remarkably high. It will be noted that in one flock the percent of infection has increased steadily in spite of the testing. In only one flock has the

disease been completely eradicated. In four flocks, the percent of infection has steadily decreased, and in the other flock the percentage of infection has fluctuated.

The two flocks tested in Lyon County made outstanding progress. In one, the disease was eradicated and in the other the infection was reduced to 2.6 percent. Both of these flock owners used good management in handling their flocks and were anxious to eradicate the disease. If all the flock owners shown on this table had been as consistent in their management as the two previously mentioned, it is very probable that they would have obtained equally good results. This table seems to indicate that just the annual testing of infected flocks with no supervision of them in regard to disposal of reactors, or sanitary measures, may reduce the percentage of infection but will not eradicate the disease, at least in a three year period. The annual testing just previous to the hatching season appears to assist in controlling chick losses from pullorum disease, although an occasional break may occur, as shown in the second year of the last flock in the table, which resulted in a 43.8 percent mortality definitely checked up by field and laboratory

diagnosis as being due to pullorum disease.

Table V. Distribution of infection by breeds

Number of counties	Breed	Number tested	Number reactors	Percent reactors
25	S.C. W. Leg.	30,666	2,053	6.6
21	S.C. R.I.R.	16,517	2,339	14.1
17	W. Wyndt.	7,816	1,472	18.8
16	W. Rocks	6,053	794	13.1
14	Bar. Ply.Rck.	6,084	1,107	18.1
11	Buff. Orp.	5,480	872	15.9
3	Rho.I.White	653	98	15.0
1	Ancona	261	35	13.4
2	W. Orpingtons	481	80	16.6
5	J. Bl. Giants	370	37	10.0
2	Buff Leg.	542	16	2.9
2	Buff Rocks	549	22	4.0
3	W. Minorcas	445	28	6.2
Totals		75,917	8,953	11.7

Table V shows a compilation of the data on flocks tested in each county according to breed. From this table it appears that the Single Comb White Leghorns carry the lowest percent (6.69) of reactors of the six leading breeds. The White Plymouth Rocks are second with 13.11 percent. The Rhode Island Reds are third, showing 14.16 percent. The Buff Orpingtons are fourth, showing 15.91 percent. The Barred Plymouth Rocks are fifth with 18.19 percent. The White Wyandottes are sixth, showing 18.83 percent reactors. There were not enough flocks or birds represented in the other breeds tabulated to give them a fair showing. There are 25 counties represented for Leghorns down to eleven counties for Buff Orpington, so this should be a fair representation of the spread of infection in the six leading breeds.

Table VI. Distribution of infection by counties

County	Number of birds	Number of reactors	Percent reactors
Atchison	466	57	12.2
Barton	4,332	519	11.9
Brown	2,590	451	17.4
Clay	7,164	964	13.4
Cloud	2,811	117	4.1
Coffey	259	50	19.3
Cowley	4,949	823	16.6
Dickinson	824	2	0.2
Edwards	3,354	267	7.9
Franklin	248	75	30.2
Geary	4,684	314	6.7
Harper	1,210	126	10.4
Jackson	1,542	111	7.1
Jewell	5,964	710	11.9
Kingman	8,251	1,155	13.9
Lincoln	3,530	338	9.5
Lyon	17,093	1,406	8.2
Marshall	672	102	15.1
Marion	4,268	989	23.1
McPherson	1,214	242	19.9
Miami	545	116	21.2
Nemaha	256	41	16.0
Ness	4,817	795	16.5
Ottawa	143	10	6.9
Pottawatomie	109	10	9.1
Riley	4,633	550	11.8
Smith	99	23	23.2
Totals	86,027	10,363	12.0

Table VI shows the number of birds, the number of reactors, and the percent of reactors in the various counties in which flock studies have been made. It will be noticed that the counties having one thousand or more birds tested, had a range of infection varying from 4.16 percent in Cloud, to 23.17 percent in Marion. Since some counties had only a few individual flocks tested, no conclusions should be drawn regarding the percentage of reactors. There was a total of 86,027 birds tested of these 10,363 or 12.04 percent were reactors. It had been suggested that heavy soils might assist in keeping the organism alive, and might be a factor in hindering eradication. In studying the percent of infection in counties having various types of soil, no relationship seems to exist. In those counties in which 1,000 or more birds were tested, Marion County, which had the highest percent of infection, has several different types of soil. Ness County shows a rather high percent of infection and is in the western part of the state where the soil is light and the climate relatively dry. Cowley and Brown Counties have about the same percent of infection as Ness, Cowley being on the southern border of the state, and Brown in the extreme northeast.

Cowley County has a light sandy loam with a heavy subsoil, and Brown County has a deep loess soil. Lyon county has a rather low percent of infection and probably has the heaviest soil of any in the list. This low percent of infection may be influenced by the fact that more than twice as many birds were tested in this county than in any other.

Table VII Consecutive yearly tests by counties

County	Year	Number flocks tested	Number birds tested	Number reactors	Percent reactors
Clay	First	11	1,922	166	8.6
"	Second	2	476	165	34.6
"	Third	6	5,899	570	9.6
"	Fourth	2	1,641	130	7.9
Cloud	First	8	2,012	64	3.1
"	Second	None			
"	Third	1	994	32	3.2
"	Fourth	None			
Jewell	First	10	1,536	390	25.3
"	Second	9	4,418	320	7.2
"	Third	None			
"	Fourth	None			
Lyon	First	40	7,867	846	10.7
"	Second	5	1,808	110	6.0
"	Third	30	23,567	1185	5.0
"	Fourth	3	3, 312	72	2.1
Ness	First	9	598	176	29.4
"	Second	7	1,802	331	18.3
"	Third	3	1,646	152	9.2
"	Fourth	2	732	170	23.2

Table VII shows five counties in which studies have been made on flocks that have been tested consecutively from one to four years. It will be noted that in Clay County the percent of infection in the flocks that have been tested for four years is nearly as great, and in the flocks that have been tested three years is greater than in those flocks tested only one year. The same is true of the one and three year tested flocks in Cloud County, although perhaps too few birds are given for comparison. Jewell County shows distinct gain in reducing the percentage of infection in two years. Lyon County is the only one in which consecutive yearly gains have been made toward complete eradication over the four year period.

In Ness County some of the flocks tested over a four year period show that the disease has steadily increased in spite of the tests, or at least been only partially held in check. This table indicates that county wide eradication of pullorum disease under the present methods of testing would be very problematical.

Table VIII Flocks free on initial test

Season	Number counties	Number flocks	Number free	Percent free
1926-27	5	21	0	0
1927-28	5	32	1	3.1
1928-29	26	258	22	8.3
Totals	36	311	23	7.3

Table IX Flocks free on second test

Season	County	Number flocks	Number free	Percent free
1927-28	Cloud	1	0	0
	Clay	11	1	9.0
	Jewell	10	0	0
	Lyon	17	0	0
	Ness	15	0	0
Totals	5 counties	54	1	1,8

Table X Flocks free on third test

Season	County	Number flocks	Number free	Percent free
1928-29	Cloud	1	0	0
	Clay	8	2	25.0
	Jewell	8	2	25.0
	Kingman	23	0	0
	Lyon	17	5	29.4
	Ness	5	0	0
Totals	6 counties	62	9	14.5

Table VIII gives an idea of the percent of flocks found free on initial test in 36 counties during the three years in which these studies were made. It was not surprising that the small number of flocks tested the first year were all found to be infected because almost all of them had produced infected chicks. In the succeeding years, however, many flock owners tested primarily because they could get a better price for their eggs and it was surprising to find so few free flocks.

Table IX shows the number of flocks found to be free of infection on second test in five widely separated counties. It will be seen the disease proved to be eradicated in only one flock out of 54 in five different counties by this method of testing.

Table X shows the number of flocks found to be free from infection on the third test. It will be seen that the attempt to eradicate pullorum disease by testing just once a year is an exceedingly slow process.

Table XI. Initial tests for three seasons

Counties	Season	Number birds tested	Number reactors	Total number birds tested	Total number reactors	Percent reactors
Clay	1926-27	679	262			
Cloud	"	473	35			
Lyon	"	487	70			
Marshall	"	672	102			
Ness	"	384	130	2,695	599	22.2
Clay	1927-28	812	92			
Cloud	"	1,405	45			
Jewell	"	819	343			
Lyon	"	1,766	209			
Ness	"	415	135	5,217	824	15.7
Atchison	1928-29	466	57			
Barton	"	4,332	519			
Brown	"	2,590	451			
Clay	"	974	48			
Cloud	"	306	4			
Coffey	"	259	50			
Cowley	"	4,949	823			
Dickinson	"	824	2			
Edwards	"	3,354	267			
Franklin	"	248	75			
Geary	"	4,684	314			
Harper	"	1,210	126			
Jackson	"	1,542	111			
Jewell	"	877	72			
Kingman	"	2,528	518			
Lyon	"	6,036	598			
Lincoln	"	3,530	338			
McPherson	"	1,214	242			
Marion	"	4,268	989			
Miami	"	545	116			
Morria	"	532	30			
Nemaha	"	256	41			
Ness	"	68	2			
Ottawa	"	143	10			
Pottawatomie	"	109	10			
Riley	"	4,041	478			
Smith	"	99	23	46,984	6,314	13.4
Totals				54,896	7,737	14.0

Table XI shows the percent of infection found on initial tests of flocks for three seasons. It will be noticed this is quite uniform considering the number of birds tested except for the first year, when rather heavily infected flocks were started. The larger number of counties and flocks considered in the season of 1928 and 1929 should give a fairly good index of the percent of infection to be found in general over the state.

Table XII. Results from hatchery flocks

County	Number of flocks tested	Number of birds tested	Number of reactors	Percent reactors	Number of free flocks
1	30	4,949	823	16.63	1
2	19	3,530	338	9.57	0
3	21	6,016	140	2.32	11
4	44	8,251	1,155	13.99	0
Totals	114	22,746	2,456	10.79	12

Table XII shows four counties in which records were kept on hatchery flocks. In counties No. 1 and No. 2, only one years records were obtainable. In counties No. 3 and No. 4, some of the flocks have been tested each year for four years. In county No. 3 the flocks were tested by a veterinarian who is very proficient in running the test. In county No. 4 the tests have all been made by a hatcheryman. From this data it appears that if the disease is to be eradicated, the control of all testing should be under the supervision of a trained veterinarian. This is shown by the results obtained in county No. 4 in which the testing was not supervised by a veterinarian. In this county the initial tests showed 13.4 percent reactors. After a four year program of testing, 13.9 percent of reactors was found. This indicates that the disease was not being eradicated in this county under present methods.

During the spring of 1929, 17 hatcheries were visited while making field studies. Of this number, 11 used forced-air-draft machines and six used still-air incubators. When the hatcherymen were questioned as to how the machines were cleaned or disinfected, it was found that eight used B-K solution, five used

formaldehyde gas once just before each hatch, two used solutions of compound cresol, one a solution of formalin, and one hot lye water. Only three of these 17 hatcherymen procured all of their eggs from tested flocks. Seven hatcherymen stated that they used separate incubators for hatching eggs from tested flocks. Ten incubated all eggs together whether from tested or untested flocks. Since it has been demonstrated that pullorum disease may be spread in any type of incubator, eradication of the disease will not progress far until strict protection of chicks from tested flocks is undertaken.

SUMMARY AND CONCLUSIONS

1. Field testing of poultry flocks for pullorum disease apparently does not increase the hatchability.

2. Chick mortality is materially reduced by the annual testing of poultry flocks.

3. The opinion of flock owners who have tested is predominately in favor of testing.

4. Subsequent tests show that when the disease has been eradicated from flocks, the eggs properly hatched, and the chicks raised away from infected

premises, it is easy to maintain these flocks free from the disease.

5. It has been shown that the breeds vary considerably in the percent of infection carried. Of the six more common breeds, the Single Comb White Leghorn carries the smallest percent of infection.

6. The type of soil upon which the flock is kept has no effect upon the eradication of pullorum disease.

7. Lyon County alone shows definite progress toward complete eradication of pullorum disease by the use of consecutive yearly tests.

8. It has been shown that when a wide range of counties and flocks are considered, very few pullorum disease free flocks are to be found on initial tests. This would make impossible in Kansas the application of Beach's (1930) recent suggestion that eggs be hatched from flocks found free on initial test.

9. The practicability of the agglutination test in eradication of pullorum disease in the hands of hatcherymen is very doubtful.

10. Few hatcherymen use efficient methods of disinfecting their incubators.

11. Most hatcherymen report that it is impractical

to hatch eggs from tested flocks separately.

These studies indicate that the failures to eradicate pullorum disease in the field are usually due to one or more of the following reasons:

1. Lack of frequent testing and non-removal of reactors.

2. The entire flock not being tested.

3. Introduction of infected stock after testing.

4. No sanitary measures after reacting birds are removed.

5. Hatching eggs in incubators which had not been properly cleaned or disinfected.

6. Hatching eggs from tested flocks with those from untested flocks.

7. Mixing chicks from tested flocks with those from untested flocks at hatching time and during early brooding.

8. Hatching chicks in incubators in rooms where down is carried from custom hatched chicks to the incubator containing chicks from tested flocks.

9. Promiscuous use of contaminated chick boxes.

10. The use of experimental and unstandardized test methods.

11. No supervision by a control agency.

12. Untrained and inexperienced poultrymen, hatcherymen, and county agents attempting to use a technical test.

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