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Poultry experiments : loss of weight in eggs during incubation

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION,
MORGANTOWN, W. VA.

BULLETIN 73.

FEBRUARY, 1901.

Poultry Experiments.

Loss of Weight in Eggs During Incubation.

BY J. H. STEWART AND HORACE ATWOOD.

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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CONCERNING LOSS IN WEIGHT OF EGGS DURING INCUBATION.

Artificial incubation is rapidly assuming immense importance not only on the large poultry farms where all of the hatching is done by incubators, but thousands of people who keep a few hens find that it is easier to hatch by artificial methods. Artificial incubation would be more widely used if poultrymen had some simple and reliable method of determining whether the eggs, while incubating, are receiving the proper amount of ventilation and at the same time are not drying up too rapidly. A proper and uniform temperature can usually be secured in most modern makes of incubators, but at the present time operators rely almost entirely upon experience to determine whether the eggs are kept sufficiently moist, and are receiving enough ventilation for best results. It is true that charts have been constructed showing the proper size of the air cell for each day of the incubating period, but in using a chart considerable experience and good judgment are necessary because the apparent size of the air cells in individual eggs may vary considerably from each other in the same incubator, and the average size of the air cells on any particular day may depart quite widely from the normal without an inexperienced operator realizing that the incubation is not progressing in a satisfactory manner. In addition, the air cells may be of the proper size and yet the embryos may perish either on account of an insufficient amount of oxygen, or because the gases resulting from the growth of the embryos are not carried away with sufficient rapidity.

It is unnecessary to describe in detail the stages in the development of a chick. The chick, however, absorbs oxygen, and moisture and certain gases are thrown off through the shell.

Under normal conditions the total amount of moisture and gases which have been thrown off at any particular time corresponds to that particular stage in the development of the chick, or in other words, when an egg is incubated under perfectly normal conditions the total loss in the weight of the egg corresponds, within certain limits, to the stage of development of the embryo.

If the operator of an incubator knows how much a certain number of eggs have lost in weight since the beginning of the incubating period and compares this loss with the normal loss of the same number of eggs for the same length of time he will know definitely whether the eggs have decreased properly in weight. If they have lost too much, providing of course that the temperature has been normal, they are drying up too rapidly, and either more moisture should be supplied, or the amount of ventilation should be reduced, but in reducing the circulation of air through the incubating chamber it must be remembered that pure air surrounding the eggs is just as important as a proper temperature; on the other hand, if the eggs are not losing weight as rapidly as they should they are either kept too moist, or they are not receiving the proper amount of ventilation, or perhaps they may be kept too moist and insufficiently ventilated also.

The object of this bulletin is to furnish sufficient data to enable the operators of incubators to exercise a more intelligent supervision over the operation of their machines. A number of experiments have been performed to determine the normal loss in the weight of eggs during incubation, and for this purpose the natural method of hatching has been employed. Eggs have been weighed, placed under broody hens in locations suitable for a perfect hatch, re-weighed on a chemical balance at suitable intervals, and the loss determined.

The following tables show the results in detail of three hatches which have been selected from a number of similar tests conducted during the past year.

TEST 1.—Eggs placed under a Rhode Island Red hen November 11, 1900. Nest situated in a cool dry cellar:

Number of Egg.	Wt., Original grams.	Wt., end of 5 days.	Wt., end of 12 days.	Wt., end of 19 days.	Result.
1	58.694	56.504	52.965	49.544	Hatched.
2	63.832	61.824	58.847	56.095	Unfertile.
3	60.212	58.244	54.920	51.604	Dead, $\frac{3}{4}$ developed.
4	53.340	50.520	46.224	42.393	Hatched.
5	52.430	50.137	46.572	43.051	"
6	50.205	47.544	43.788	40.107	"
7	49.197	47.224	44.431	41.739	"
8	50.805	48.752	45.800	43.064	Unfertile.
9	55.484	53.339	50.294	47.212	Hatched.
10	52.585	50.435	47.184	43.970	Dead, fully developed.

Table showing the loss in weight of the eggs which hatched:

Number of Egg.	Loss first 5 days.	Loss next 7 days.	Loss next 7 days.	Total loss for 19 days.
1	2.190	3.539	3.421	9.150
4	2.820	4.296	3.831	10.947
5	2.293	3.565	3.521	9.379
6	2.661	3.756	3.681	10.098
7	1.973	2.793	2.692	7.458
9	2.145	3.045	3.082	8.272
Average loss per egg	2.347	3.499	3.371	9.217
Average loss per day	.469	.499	.481	.484
Percentage loss	<i>Per ct.</i> 4.41	<i>Per ct.</i> 6.87	<i>Per ct.</i> 7.11	<i>Per ct.</i> 17.31

Table showing the loss in weight of the fertile eggs which did not hatch.

Number of Egg.	Loss first 5 days.	Loss next 7 days.	Loss next 7 days.	Total loss for 19 days.
3	1.968	3.324	3.316	8.608
10	2.150	2.251	3.214	8.615
Average loss per egg	2.059	3.287	3.265	8.611
Average loss per day	.411	.469	.466	.453
Percentage loss	<i>Per ct.</i> 3.65	<i>Per ct.</i> 6.04	<i>Per ct.</i> 6.39	<i>Per ct.</i> 15.25

Table showing the loss in weight of the unfertile eggs:

Number of Egg.	Loss first 5 days.	Loss next 7 days.	Loss next 7 days,	Total loss for 19 days.
2.....	2.008	2.977	2.752	7.737
8.....	2.053	2.952	2.736	7.741
Average loss per egg.....	2.030	2.964	2.744	7.738
Average loss per day.	.406	.423	.392	.407
	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Percentage loss	3.54	5.36	5.24	13.50

The preceding tables show that all of the eggs decreased more rapidly in weight during the latter part than during the first part of the incubating period. Also that the unfertile eggs decreased considerably less than the ones which hatched, the eggs in which the germs were weak standing midway between the two extremes.

It is a matter of importance to know whether a heavy egg will decrease more in weight than a lighter one. In order to consider this point we may divide the eggs which hatched in the above test according to their weight. Numbers 1, 4, and 9 had an average weight of 55.839 grams and lost during the nineteen days of the test 9.456 grams, or at the rate of 16.9 per cent. On the other hand the lighter eggs, 5, 6, and 7, with an average weight of 50.610 grams, gave an average decrease in weight of 8.978 grams, which is at the rate of 17.7 per cent., it is thus seen that although the larger eggs lost more in weight than the smaller ones, yet they suffered a slightly smaller percentage loss.

TEST 2.—Eggs placed under a Rhode Island Red hen January 28, 1901. Nest situated in a dry room kept moderately warm:

Number of Egg.	Original weight, grams.	Weight at end of 5 days,	Weight at end of 12 days,	Weight at end of 19 days.	Result.
1	54.245	51.294	47.109	42.516	Hatched.
2.....	56.391	54.244	52.135	49.545	"
3.....	58.136	55.215	51.026	46.445	"
4.....	67.391	65.081	62.125	58.866	"
5.....	55.451	52.685	49.379	45.439	"
6.....	64.530	61.900	58.534	54.734	"
7.....	59.543	57.225	54.039	50.606	"
8.....	64.481	61.882	58.419	54.590	"
9.....	62.529	60.095	56.791	53.099	"
10.....	56.394	53.772	50.431	46.625	"
11.....	53.991	51.799	Broken.		
12.....	55.201	52.980	50.062	46.785	Hatched.

The above table shows a remarkably good hatch. Twelve eggs were placed under a hen, and with the exception of the one broken after the second weighing, all hatched and the chicks were strong and vigorous.

Table showing the loss in weight of the eggs.

Number of Egg.	Loss first 5 days.	Loss next 7 days.	Loss next 7 days.	Total loss for 19 days.
1.....	2.951	4.185	4.593	11.729
2.....	2.147	2.109*	2.590*	6.846
3.....	2.921	4.189	4.581	11.691
4.....	2.310	2.956*	3.259*	8.525
5.....	2.766	3.306	3.940	10.012
6.....	2.630	3.366	3.800	9.796
7.....	2.318	3.186	3.433	8.937
8.....	2.599	3.463	3.829	9.891
9.....	2.434	3.304	3.692	9.430
10.....	2.622	2.341	3.806	9.769
11.....	2.192			
12.....	2.221	2.918	3.277	8.416
Average loss per egg.....	2.538	3.302	3.709	9.549
Average loss per day	.507	.471	.529	.502
Percentage loss.....	<i>Per ct.</i> 4.26	<i>Per ct.</i> 5.79	<i>Per ct.</i> 6.91	<i>Per ct.</i> 16.05

* Covered with broken egg.

In this test it is seen that the greatest percentage loss was during the third period, or from the twelfth to the nineteenth day,

the eggs losing during that time slightly less than 1 per cent. daily, the percentage loss being calculated from the weight of the eggs at the beginning of the third period.

During the second period, or from the fifth to the twelfth day, the daily percentage loss is slightly less than during the first five days and also considerably less than during the same period in test 1. This small loss was undoubtedly due to the breakage of egg No. 11, which would reduce somewhat the temperature of the remaining eggs during this period, and by partially covering numbers 2 and 4 prevent them from decreasing as much as they otherwise would.

LARGE VERSUS SMALL EGGS.—Dividing the eggs into two groups according to their weight we have numbers 4, 6, 7, 8, and 9 with an average weight of 63.695 grams and with an average loss of 9.315 grams. The remaining eggs whose average is 55.969 grams lost an average weight of 9.744 grams. Consequently in this test the lighter eggs lost more weight than the others.

TEST 3.—Eggs placed under a Rhode Island Red hen February 1, 1901. Nest situated in a room kept moderately warm except during the last five days of the hatch, when the temperature unavoidably fell nearly to the freezing point.

umber of Egg.	Original weight, grams.	Weight at end of 5 days.	Weight at end of 12 days.	Weight at end of 19 days.	Result.
1.....	64.294	62.257	59.204	56.088	Unfertile.
2.....	66.885	64.410	60.631	56.820	Hatched.
3.....	67.994	63.840	61.026	56.665	Dead in shell.
4.....	56.868	55.026	52.056	49.000	Hatched.
5.....	66.790	64.159	60.046	56.001	Dead in shell.
6.....	60.080	57.487	53.536	49.864	Unfertile.
7.....	55.915	53.768	50.305	46.819	Hatched.
8.....	57.160	55.012	51.776	48.191	"
9.....	59.189	56.946	53.134	49.229	"
10.....	54.324	52.204	48.707	45.274	"
11.....	52.793	50.351	46.501	42.845	"
12.....	48.880	46.821	43.505	40.107	"
13.....	53.121	51.114	47.947	44.721	"

Of the thirteen eggs all hatched but four, two of the eggs being unfertile and two with weak germs.

The following table shows the loss in weight of each egg which hatched for each of the three periods, and the total loss for the nineteen days of the test:

Number of Egg	Loss first 5 days.	Loss next 7 days.	Loss next 7 days.	Total loss for 19 days.
2.....	2.475	3.779	3.811	10.065
4.....	1.842	2.970	3.056	7.868
7.....	2.147	3.463	3.486	9.096
8.....	2.148	3.236	3.585	8.969
9.....	2.243	3.812	3.905	9.960
10.....	2.120	3.497	3.433	9.050
11.....	2.442	3.850	3.656	9.948
12.....	2.059	3.316	3.398	9.773
13.....	2.007	3.167	3.226	8.400
Average loss per egg.....	2.164	3.454	3.506	9.125
Average loss per day.....	.493	.493	.501	.480
Percentage loss.....	<i>Per ct.</i> 3.85	<i>Per ct.</i> 6.40	<i>Per ct.</i> 6.94	<i>Per ct.</i> 16.25

Table showing the loss in weight of the fertile eggs which did not hatch:

Number of Egg.	Loss first 5 days.	Loss next 7 days.	Loss ext 7 days.	Total loss for 19 days.
3.....	2.654	4.314	4.361	11.329
5.....	2.631	4.113	4.045	10.789
Average loss per egg.....	2.642	4.213	4.203	11.058
Average loss per day.....	.528	.602	.600	.582
Percentage loss.....	<i>Per ct.</i> 3.92	<i>Per ct.</i> 6.5	<i>Per ct.</i> 6.94	<i>Per ct.</i> 16.41

Table showing the loss in weight of the unfertile eggs:

Number of Egg.	Loss first 5 days.	Loss Next 7 days.	Loss next 7 days.	Total loss for 19 days.
1.....	2.037	3.053	3.116	8.206
6.....	2.593	3.951	3.672	10.216
Average loss per egg.....	2.315	3.502	3.394	9.211
Average loss per day.....	.463	.500	.485	.484
Percentage loss.....	<i>Per ct.</i> 3.72	<i>Per ct.</i> 5.84	<i>Per ct.</i> 6.02	<i>Per ct.</i> 14.81

An inspection of the above tables shows that the eggs which hatched decreased more rapidly in weight during the latter part than during the first part of the period of incubation. The two fertile eggs which did not hatch lost almost the same amount of weight as the eggs which hatched; the dead chicks were perfectly formed, but for some unknown reason were not hatched. The unfertile eggs, as in test no 1, did not lose so much weight as the fertile ones.

THE LOSS IN WEIGHT OF LARGE VERSUS SMALL EGGS.—We may divide the eggs which hatched in the above test according to their original weight. Eggs 2, 4, 8, and 9 having an average weight of 60.025 grams, suffered an average loss of 9.215 grams, or at the rate of 15.35 per cent. Eggs 7, 10, 11, 12, and 13, with an average weight of 53.006 grams, gave an average decrease of 9.053 grams, or at the rate of 17.07 per cent. It is thus seen that although the larger eggs lost more weight than the smaller, yet they lost a smaller per cent. of their original weight.

The following table shows the loss in weight of the eggs which hatched in the three different tests:

	Total loss per Egg During—			
	First 5 days.	Next 7 days.	Next 7 days.	19 days.
Test 1.....	2.347	3.499	3.371	9.217
Test 2.....	2.538	3.302	3.709	9.549
Test 3.....	2.164	3.454	3.506	9.124
Average.....	2.349	3.418	3.528	9.297

The following table shows the percentage loss in weight of the eggs which hatched:

	Percentage Loss of Weight for—			
	First 5 days.	Next 7 days.	Next 7 days.	19 days.
Test 1.....	4.41	6.87	7.11	17.31
Test 2.....	4.26	5.79	6.91	16.05
Test 3.....	3.85	6.40	6.94	16.25
Average.....	4.17	6.35	6.98	16.55
Average daily loss.....	.83	.90	1.00	.87

The above tables show that in the case of the eggs which hatched the daily as well as the percentage loss increased as the period of incubation advanced.

The following table shows the average loss in weight of the fertile eggs which did not hatch:

	Total Loss per Egg During—			
	First 5 days.	Next 7 days.	Next 7 days.	19 days.
Test 1.....	2.059	3.287	3.265	8.611
Test 3.....	2.642	4.213	4.203	11.058
Average.....	2.350	3.750	3.734	9.835

The following table shows the percentage loss of the same eggs:

	Average percentage loss during—			
	First 5 days.	Next 7 days.	Next 7 days.	19 days.
Test 1.....	3.65	6.04	6.39	15.26
Test 3.....	3.92	6.50	6.94	16.41
Average.....	3.78	6.27	6.66	15.83
Average daily loss.....	.75	.89	.95	.83

The average loss in weight of the unfertile eggs is shown below:

	Total Loss per Egg During—			
	First 5 days	Next 7 days.	Next 7 days.	19 days.
Test 1.....	2.030	2.964	2.744	7.738
Test 3.	2.315	3.502	3.394	9.211
Average.....	2.172	3.233	3.069	8.474

The following table shows the percentage loss of the same eggs.

	Average Percentage Loss During—			
	First 5 days.	Next 7 days.	Next 7 days.	19 days.
Test 1.....	3.54	5.36	5.24	13.50
Test 3.....	3.72	5.84	5.02	14.81
Average.....	3.63	5.60	5.63	14.15
Average daily loss.....	.72	.80	.80	7.44

In the following table are brought together the results of the preceding averages:

	Total Loss per Egg During—			
	First 5 days.	Next 7 days.	Next 7 days.	19 days.
Eggs which hatched.....	2.349	3.418	3.528	9.297
	<i>Per ct.</i> 4.17	<i>Per ct.</i> 6.35	<i>Per ct.</i> 6.98	<i>Per ct.</i> 16.54
Fertile eggs which did not hatch.....	2.350	3.750	3.734	9.835
	<i>Per ct.</i> 3.78	<i>Per ct.</i> 6.27	<i>Per ct.</i> 6.66	<i>Per ct.</i> 15.83
Unfertile eggs.....	2.172	3.233	3.069	8.474
	<i>Per ct.</i> 3.60	<i>Per ct.</i> 5.60	<i>Per ct.</i> 5.63	<i>Per ct.</i> 14.15

The table shows that the eggs which hatched lost, during the 19 days of the test, a greater percentage of their original weight than either the unfertile eggs or those with weak germs. Also in the case of the fertile eggs the daily loss increased as the incubation proceeded.

SUMMARY AND CONCLUSION.

1. Fertile eggs, when incubated in a normal manner, decrease in weight.

2. The eggs which hatched lost 4.17 per cent. of their weight during the first five days of incubation. During the seven succeeding days they lost 6.35 per cent. of the weight of the eggs at the end of the fifth day, and during the next seven days lost 6.98 per cent. of their weight at the end of the twelfth day.

3. One hundred fertile eggs of average size will lose 234.9 grams, or 8.28 ounces, during the first five days of incubation; 341.8 grams, or 12.05 ounces, during the next seven days; and 352.8 grams, or 12.44 ounces, during the next seven days.

4. The unfertile eggs lost 3.6 per cent. of their original weight during the first five days of incubation. During the seven succeeding days they lost 5.6 per cent. of what they weighed at the end of the fifth day, and during the next seven days lost 5.6 per cent. of their weight on the twelfth day.

One hundred unfertile eggs will lose 217.2 grams, or 7.66 ounces, during the first five days; 323.3 grams, or 11.40 ounces, during the next seven days; 306.9 grams, or 10.82 ounces, during the next seven days.

SUGGESTIONS CONCERNING THE USE OF THESE RESULTS.

Before placing eggs in an incubator they should be weighed upon a pair of scales reading to ounces. This may be done very conveniently by first weighing the trays, placing the eggs upon them ready for the incubator, and then weighing trays and eggs together. The difference will be the weight of the eggs. At the end of the fifth day the eggs and trays should be re-weighed, the loss in weight determined, and compared with the figures given in the Summary and Conclusion of this bulletin. It is important, however, that the trays be thoroughly dry when first weighed, as wooden trays, especially when recently washed, may appear quite dry and yet contain several ounces of water, which will evaporate when the trays are placed in the incubator, and thus make the loss in weight of the eggs during the first five days appear larger than it really is.

HORACE ATWOOD.

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