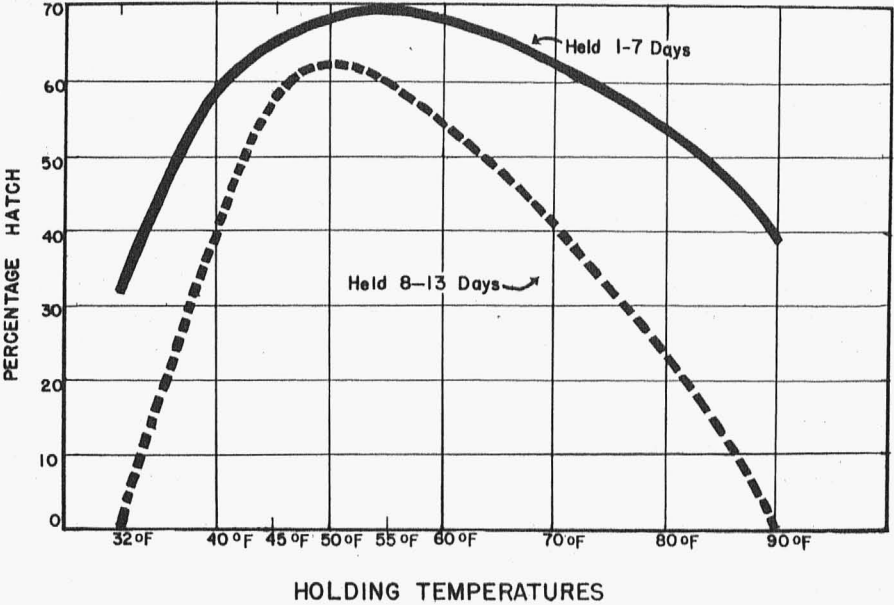


# EFFECT OF HOLDING TEMPERATURES ON HATCHABILITY OF EGGS



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BULLETIN 539

MAY, 1950

## CONCLUSIONS REACHED IN THIS STUDY

Eggs held for one day or longer at optimum temperatures hatched better than did eggs set the day they were laid.

The most satisfactory temperature for holding hatching eggs was from 45°F. to 55°F.

Exposing eggs to sub-freezing temperatures seriously reduced hatchability within a few hours. Eggs held at 0°F. for 3 hours hatched at a rate of 29.5 per cent as compared to 75 per cent for those held 1 hour at that temperature.

Holding eggs at high temperatures was detrimental to hatchability. Eggs held at 90°F. began losing their hatchability after being held 2 days and all those held over 7 days at that temperature failed to hatch.

The length of time hatching eggs may be held depends upon the temperature at which they have been held. However, eggs held at optimum temperatures showed some decline in hatchability if held more than 7 days.

There appear to be differences between breeds and crosses in the ability of their eggs to retain their hatchability when held at higher temperatures.

# EFFECT OF HOLDING TEMPERATURES ON HATCHABILITY OF EGGS

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## INTRODUCTION

It is estimated that in 1949 the commercial hatcheries in the United States produced 1530 million chicks and that the five-year average was approximately 1.4 billion chicks. Assuming a hatch of 70 per cent, 2 billion eggs a year would be required for hatching purposes. An estimated total of 600 million unhatched eggs would be left in the incubator trays. From one-third to nearly one-half of this loss may be due to infertile eggs which leaves a balance of 300 million to 400 million fertile eggs which fail to hatch for some unknown reason. Any attempt to reduce this loss is of economic importance. Successful hatchery management depends upon a reasonable degree of success in attaining good hatches. One phase of this problem is the care of the eggs from the time they are laid until placed in the incubator.

The hatching of an egg is the culmination of a series of complicated biological processes. Any factor affecting these processes influences the hatchability of the egg. Research has established the fact that holding temperatures play an important part in the hatching of eggs. Many workers have studied the effect of temperature on hatchability but most of the reports are on small lots of eggs and with inadequately controlled temperatures.

Some of the early workers reporting that the length of time eggs can be held without injuring hatchability depends on holding temperature were de Reaumur, 1749; de Lavison, 1862; and Dareste, 1882, 1883 and 1886.

Edwards in 1902 stated that the physiological zero of chicken eggs was near 68°F., but more recently Funk and Biellier (1944) suggested that it is several degrees higher.

As early as 1909, Philips reported that eggs held for 14 days at 80°F. failed to hatch.

Careful studies by Moran (1925) have shown that the optimum storage temperature is between 46°F. and 50°F.

Scott (1933) stored two lots of White Leghorn eggs at average temperatures of 36.3°F. and 54.2°F. He found that the hatchability of White Leghorn eggs was greatly reduced when held at 36.3°F. for 0 to 6 days. White Leghorn eggs held at 54.2°F. for 0 to 6 days hatched well.

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\***Acknowledgment.** This research was made possible by a grant from the International Baby Chick Association.

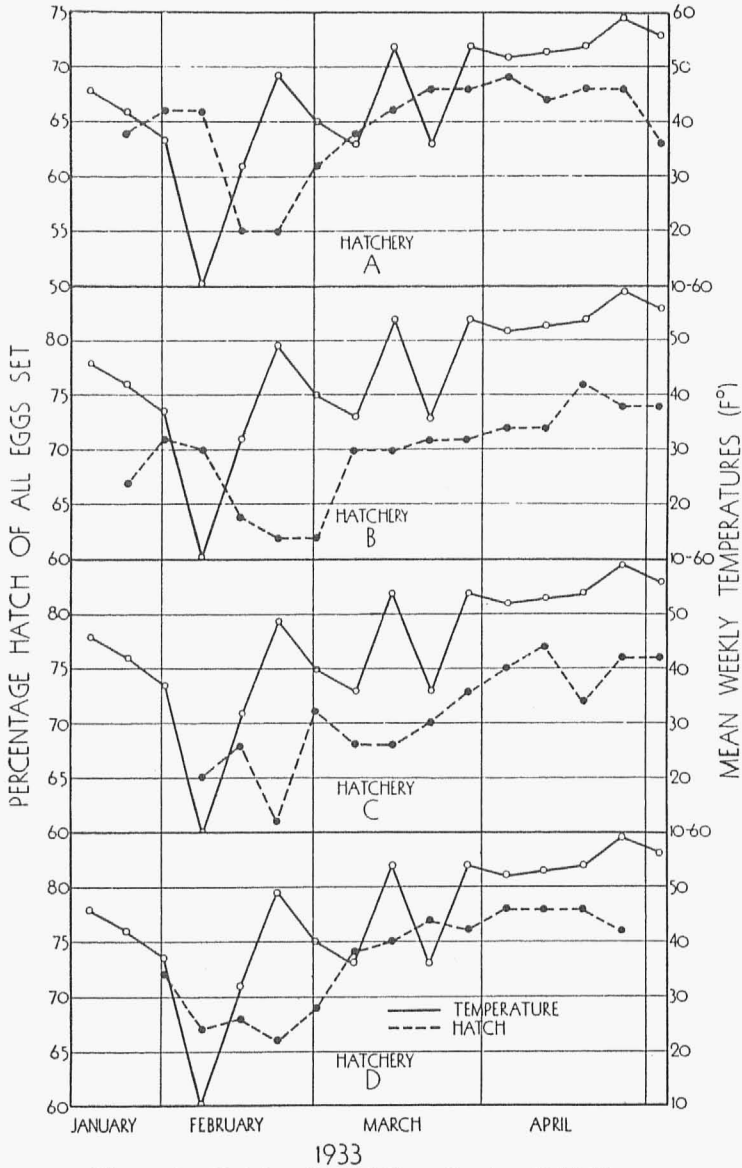


Figure 1. Hatchability of Eggs During Cold Wave.

Funk (1934) reported that hatches may be seriously affected by cold weather. The experiences of four Missouri hatcheries with eggs laid during and following a cold wave are represented in Figure 1. The percentage hatch of all eggs declined approximately 10 per cent after an abrupt drop in temperature. Eggs delivered by the farmers during the week of the "cold wave" were not affected but eggs delivered from one to three weeks after the cold weather were

affected. The "cold wave" indicated here was of short duration as is shown by the chart and the effects were not so serious as those often resulting when more severe cold weather occurs.

The experience of hatcherymen during hot weather also confirms our laboratory findings that high temperatures are detrimental to hatching. Figure 2 shows the experience of a Missouri hatchery that operated during the summer of 1930 (a very hot summer). The

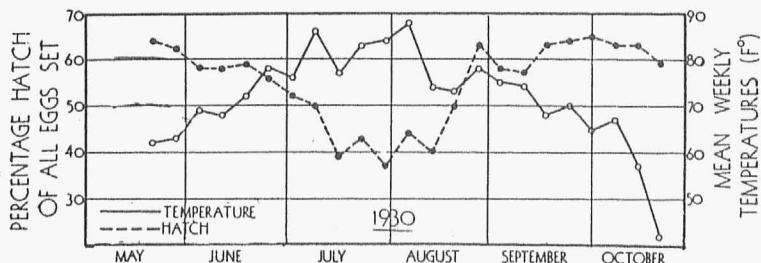


Figure 2. Hatchability of Eggs During Hot Weather

percentage of hatch of all eggs obtained by this hatchery declined about 25 per cent during the hot weather. Most of this decline could likely be attributed to the high temperature at which the eggs were held before they were delivered to the hatchery.

Phillips (1945) reported that storage of eggs from New Hampshire pullets for 1 to 7 days at 32°F., 38°F., and 52°F. did not cause significant difference in hatchability. He suggested the possibility of differences between breeds of chickens in the ability of their embryos to withstand low temperatures.

Talmadge (1947) reported hatching results when White Plymouth Rock eggs were held for 1 to 7 days at 90°F., at 38°F. to 40°F. and at 70°F. to 76°F. He concluded that holding eggs for 1 to 7 days at 38°F. to 40°F. and at 70°F. to 76°F. had no detrimental effect on hatchability. He reported further that the hatchability of eggs stored at 90°F. for 1 to 4 days was not affected, but that eggs held at this temperature for 5, 6 or 7 days hatched poorly.

Jull, McCartney and El-Ibiary (1947) reported that holding chicken (New Hampshire) hatching eggs at -1°F. for as long as 10 hours and with a reduction of the internal egg temperature to 30.2°F. did not seriously impair their hatchability. Turkey eggs exposed to -1°F. for 1, 2, 3, or 4 hours hatched more poults than did control eggs held at 50°F. to 55°F. Jull, et al., further reported hatching some chicks from eggs in which the temperature had been reduced to 3.2°F.)

Olsen and Haynes (1948) held White Leghorn and Rhode Island Red eggs at temperatures ranging from 30°F. to 70°F. and found that eggs held at 30°F. gave the lowest hatch and those held at 50°F. the highest. There was little difference between eggs held at 50°F. and 55°F.

### I. RAPID COOLING OF HATCHING EGGS BEFORE HOLDING AND ITS EFFECT ON HATCHABILITY

Since hatchability of hatching eggs declines following severe drops in temperature, a study of the effects of exposing hatching eggs to extremely low temperatures was studied. The eggs used in these tests were from a University flock of New Hampshire pullets. The eggs were gathered at frequent intervals beginning at 7:30 a. m. and ending at 5 p. m. Immediately after collection, the eggs were subjected to temperatures ranging from  $-10^{\circ}\text{F.}$  to  $35^{\circ}\text{F.}$  for various lengths of exposure, after which they were held from 0 to 6 days at a temperature of  $55^{\circ}\text{F.}$  before being placed in the incubator. The control eggs were held at  $55^{\circ}\text{F.}$

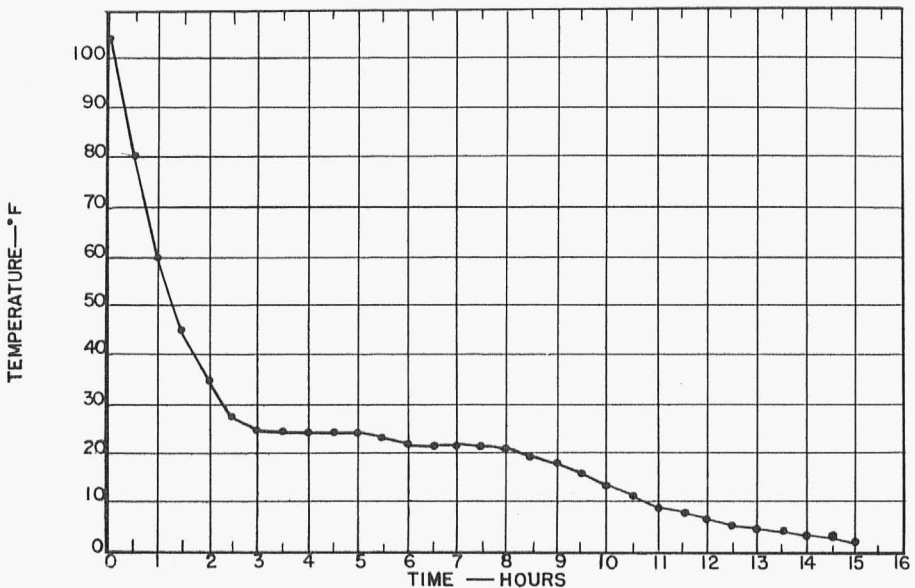


Figure 3. The rate of Cooling of an Egg at  $0^{\circ}\text{F.}$

The eggs were cooled in filler-flats in single layers. Lot 1 was subjected to  $0^{\circ}\text{F.}$  temperature.

A Micromax recorded the temperature of the cooler throughout the test. A thermocouple placed in the center of an egg gave a record of the rate of cooling of an egg. One egg started at  $105^{\circ}\text{F.}$ , cooled to  $60^{\circ}\text{F.}$  in one hour and to  $35^{\circ}\text{F.}$  in two hours. At two hours and 34 minutes the temperature of the egg was  $27^{\circ}\text{F.}$  Four minutes later the temperature was  $26^{\circ}\text{F.}$ ; the next reading showed the egg temperature to be  $26^{\circ}\text{F.}$  The temperature continued down slowly. The total time to cool to  $0^{\circ}\text{F.}$  was 18 hours and 15 minutes. Figure 3 shows the rate of cooling of an egg to  $0^{\circ}\text{F.}$

Table 1 also shows the effect of cooling eggs at  $0^{\circ}\text{F.}$  immediately

after laying and holding at 55°F. for 0 to 6 days on their hatchability. Eggs cooled 4 hours had 3.57% cracked; 7.3% of those cooled for 5 hours were cracked and 16.6% cooled for 6 hours were cracked.

Table 1. Hatchability of Eggs Cooled at 0°F. Immediately After Laying and Held at 55°F. 0 - 6 days

Treatment	Eggs Cooled	Eggs Cracked	Eggs Set	Per cent				
				Infertile	Dead before blood formed	Dead 2-18 days	Dead in Shell	Hatch
Controls	180	0	180	8.33	2.78	15.00	7.78	66.11
Cooled 1 hr.	176	0	176	4.55	.57	11.36	8.52	75.00
Cooled 2 hrs.	192	0	192	3.65	.52	11.46	9.37	75.00
Cooled 3 hrs.	193	0	193	3.11	.52	61.66	5.18	29.53
Cooled 4 hrs.	168	6	162	5.56	2.47	54.32	9.26	28.39
Cooled 5 hrs.	137	10	127	1.57	1.57	64.57	7.87	24.42
Cooled 6 hrs.	114	19	95	1.05	0	78.95	4.21	15.79

Table 2. Hatchability of Eggs Cooled at 30°F. Immediately After Laying and Held at 55°F. 0 - 6 days.

Treatment	Eggs Set	Per cent				
		Infertile	Dead before blood formed	Dead 2-18 days	Dead in Shell	Hatch
Controls	179	7.3	0.6	7.8	13.4	70.95
Cooled 1 hr.	140	3.6	2.1	8.6	12.9	72.9
Cooled 3 hrs.	143	7.7	0	6.3	15.4	70.6
Cooled 6 hrs.	204	7.4	1.0	7.4	16.2	68.1
Cooled 9 hrs.	155	5.2	.6	6.5	18.1	69.7
Cooled 18 hrs.	149	4.0	.7	10.7	18.8	65.8
Cooled 24 hrs.	167	4.19	1.2	24.6	15.0	61.1

Eggs cooled for 1 to 2 hours immediately after laying hatched 75% while those placed at 55°F. immediately after laying hatched 66.11%. This seemingly large difference in percentage of hatch is not significant in a sample of this size, but attention should be called to the fact that the percentage of infertiles and percentage dead before blood formed was higher for the control group. Eggs cooled longer than 2 hours showed an abnormally high percentage of embryonic deaths from 2 to 18 days of incubation. The greater part

of these deaths occurred near the fifth day of incubation.

Table 2 shows the effect of cooling eggs at 30°F. immediately after laying and holding 0 to 6 days at 55°F.

Eggs cooled 1 hour at 30°F. hatched slightly better than controls. Cooling eggs 3, 6, 9 and 18 hours gave increasing percentages of embryos dying in the shell. Eggs cooled for 24 hours had three times as many embryonic deaths 2 to 18 days as the controls.

A thermocouple placed in an egg showed that it took four hours to reduce the temperature of an egg from 90°F. to 32°F. when held at 30°F.

Table 3. Hatchability of Eggs Cooled at 35° F. the Day Laid and Held 0 - 6 days at 55° F.

Treatment	Eggs Set	Per cent				Hatch
		Infertile	Dead before blood formed	Dead 2-18 days	Dead in Shell	
Controls	228	3.5	1.3	7.5	17.1	70.6
Cooled 4 hrs.	227	3.5	0	8.4	10.1	78.0
Cooled 8 hrs.	222	3.6	1.4	8.1	18.0	68.9
Cooled 24 hrs.	222	2.3	0	7.7	14.4	75.7

Table 4. Hatchability of Eggs Cooled at 20° F. the Day Laid and Held 0 - 6 days at 55° F.

Treatment	Eggs Set	Per cent				Hatch
		Infertile	Dead before blood formed	Dead 2-18 days	Dead in Shell	
Controls	286	5.6	.3	9.8	9.8	74.5
Cooled 30 min.	266	5.3	.4	10.5	11.3	72.6
Cooled 60 min.	266	6.0	0.0	6.8	11.7	75.6
Cooled 90 min.	266	4.5	.4	14.7	29.3	51.9

Table 3 shows the effect of cooling eggs gathered at two-hour intervals 4 to 24 hours at 35°F. and holding 0 to 6 days at 55°F.

Eggs cooled 4 hours and 24 hours hatched slightly better than eggs placed at 55°F. immediately after gathering. Eggs held 8 hours hatched slightly less, but there is no significant difference in percentage of hatch of these small lots of eggs.

Table 4 shows the effect of cooling eggs at 20°F. at end of laying day, and holding 0 to 6 days at 55°F. Eggs cooled 30 and 60 minutes



hatched as well as eggs not pre-cooled, but eggs cooled 90 minutes hatched significantly less than controls.

Table 5 shows the effect of cooling eggs at  $-10^{\circ}\text{F}$ . at end of day laid. Cooling 15 minutes to 45 minutes had no effect on hatchability.

**Table 5. Hatchability of Eggs Cooled at  $-10^{\circ}\text{F}$ . the Day Laid and Held 0 - 6 days at  $55^{\circ}\text{F}$ .**

Treatment	Eggs Set	Per cent					Hatch
		Infertile	Dead before blood formed	Dead 2-18 days	Dead in Shell		
Controls	171	8.8	1.8	7.0	9.4	73.1	
Cooled 15 min.	173	8.7	.6	10.4	8.7	71.7	
Cooled 30 min.	174	9.2	1.7	6.9	11.5	70.7	
Cooled 45 min.	171	7.6	1.2	11.7	7.0	72.5	

**Table 6. Hatchability of Old Hen Eggs When Cooled 1 hr. at  $10^{\circ}\text{F}$ . Within 2 hrs. after Laying and Held 0 - 13 days at  $55^{\circ}\text{F}$ .**

Treatment	Eggs Set	Per cent					Hatch
		Infertile	Dead before blood formed	Dead 2-18 days	Dead in Shell		
Controls	378	5.0	.3	14.3	17.5	63.0	
Cooled 1 hr.	397	6.8	1.0	19.4	19.6	53.1	

Table 6 shows the effect of cooling eggs at  $10^{\circ}\text{F}$ . for one hour, when eggs were gathered at 2-hour intervals and held 0 to 13 days at  $55^{\circ}\text{F}$ . These eggs were laid by New Hampshire and White Plymouth Rock hens June 15 to July 17th. The eggs that were cooled 1 hour hatched significantly less than control eggs.

The effect of sub-freezing temperatures on hatching results indicates that exposure of eggs to a temperature of  $-10^{\circ}\text{F}$ . for 45 minutes did not impair hatchability. These eggs were exposed on single layer filler flats in still air. Those held at  $0^{\circ}\text{F}$ . for 1, 2, 3, 4, 5 and 6 hours resulted in some of the eggs being cracked after 4 hours of such exposure, but such eggs were not set. The results of this test show that hatching results were seriously reduced by 3 hours of exposure at this temperature.

Exposing eggs to a temperature of  $20^{\circ}\text{F}$ . for not more than 1 hour did not impair hatchability. Eggs exposed for 18 hours at  $30^{\circ}\text{F}$ . or 24 hours at  $35^{\circ}\text{F}$ . retained their hatching power. It would

appear from these results that if reasonable care is given hatching eggs during cold weather the decline in hatchability following cold waves due to exposure of eggs to cold may be reduced to a minimum.

## II. EFFECT OF PRE-INCUBATION TEMPERATURES OF HATCHING EGGS ON HATCHABILITY

In this phase of the work eggs were held before setting from 0 to 13 days at various temperatures ranging from 32° to 90°.

The eggs were produced from April 21 to July 13, 1949 by New Hampshire and White Plymouth Rock pullet flocks at the University Poultry Farm. They were gathered four times daily and kept in the University egg room until 5:00 p. m., when they were taken to the egg laboratory. There the eggs were divided into the lots used in this temperature study and placed in coolers. These coolers maintained the desired temperature  $\pm$  2°F. All eggs were held 1 to 13 days. Eggs set the day laid were used as controls.

All eggs were incubated in the same setter operated at 99 $\frac{3}{4}$ °F. with a wet bulb reading of 86°F. On the eighteenth day of incubation all eggs were candled and the live embryos transferred to a separate hatcher operated at 99°F. and a wet bulb reading of 90°F. All clear eggs were broken to determine if there had been any development after setting.

The results are shown as percentage of all eggs set, which is the measure used by hatcherymen. With the exception of the eggs held at 32°F. and 40°F., the percentage of eggs failing to show embryo development was approximately 8 per cent. The eggs held at 32°F. and 40°F. showed a higher percentage of "infertile eggs". The differences in percentage hatch at holding temperatures above 40°F. was caused by the difference in the percentage of embryos dying during incubation.

### RESULTS OF ALL TESTS

The results of all tests are shown in Table 7. It is apparent from these data that the optimum temperature for holding eggs is within the range of 45°F. to 55°F. and that there are no significant differences in the results for eggs held at 45°F., 50°F. and 55°F. Attention should be called to the fact that in practically all instances regardless of the temperature to which the eggs were exposed, eggs held for 1 day or longer hatched better than did the controls which were set the day laid. The average hatchability of all eggs held at 45°F., 50°F. or 55°F. did not fall below the controls if held for less than 10 days (Table 8, Figure 4).

Holding eggs at temperatures below 45°F. for a short time did not seriously impair hatchability. At 40°F. a sharp decline occurred after 4 days. A decided drop in hatchability occurred for eggs held 3 days at freezing temperatures. Hatchability reached 0 per cent for eggs held at this cold temperature after 5 or more days. At the 40° temperature the decline in hatchability gradually declined reach-

Table 7. Relation of Holding Temperature Before Incubation to Hatchability of Eggs. New Hampshire Eggs Laid Between April 21 and July 13, 1949.

Days Held	32° F.		40° F.		45° F.		50° F.		55° F.		60° F.		70° F.		80° F.		90° F.	
	Eggs Set	% Hatch all Eggs	Eggs Set	% Hatch all Eggs	Eggs Set	% Hatch all Eggs	Eggs Set	% Hatch all Eggs	Eggs Set	% Hatch all Eggs	Eggs Set	% Hatch all Eggs	Eggs Set	% Hatch all Eggs	Eggs Set	% Hatch all Eggs	Eggs Set	% Hatch all Eggs
1	16	62.5	89	69.7	103	63.1	106	70.8	104	64.4	103	59.2	104	59.6	106	68.8	40	72.5
2	20	65.0	98	70.4	113	70.8	113	66.4	108	63.9	108	63.0	109	60.6	108	62.0	36	58.3
3	14	35.7	91	64.8	106	72.6	107	68.2	106	67.0	109	61.5	111	64.9	113	64.6	42	57.1
4	18	50.0	90	65.6	109	62.4	105	68.6	107	67.3	104	56.7	108	62.0	107	57.9	41	46.3
5	16	0	95	50.5	110	55.6	104	64.4	110	60.0	106	58.5	105	54.3	107	50.5	40	22.5
6	16	0	92	51.1	109	56.0	108	69.4	107	59.8	109	56.0	107	66.4	109	50.5	37	18.9
7	18	0	92	41.3	110	71.8	108	67.6	108	60.2	108	62.0	111	59.5	108	44.4	40	0
8	18	0	93	36.6	103	59.2	104	61.4	105	63.8	100	59.0	100	50.0	101	37.6	28	0
9	20	0	96	24.0	116	69.0	117	65.0	117	59.0	108	57.4	118	47.5	120	26.7	33	0
10	18	0	90	40.0	107	65.4	106	52.8	107	57.9	113	49.6	104	36.5	106	25.5	29	0
11	16	0	92	18.5	109	57.8	110	57.3	114	62.3	117	47.0	116	38.8	117	12.8	31	0
12	10	0	95	21.1	111	55.9	115	53.9	108	55.6	110	44.5	113	36.3	113	7.1	28	0
13	18	0	88	6.8	105	56.2	106	66.0	110	60.9	104	47.1	110	32.7	109	.9	31	0
Total	218	16.2	1193	43.4	1411	63.2	1419	63.3	1413	61.0	1399	55.5	1416	50.2	1424	39.4	456	20.9
*Con- trols	828	59.9																

\*Controls set day laid.

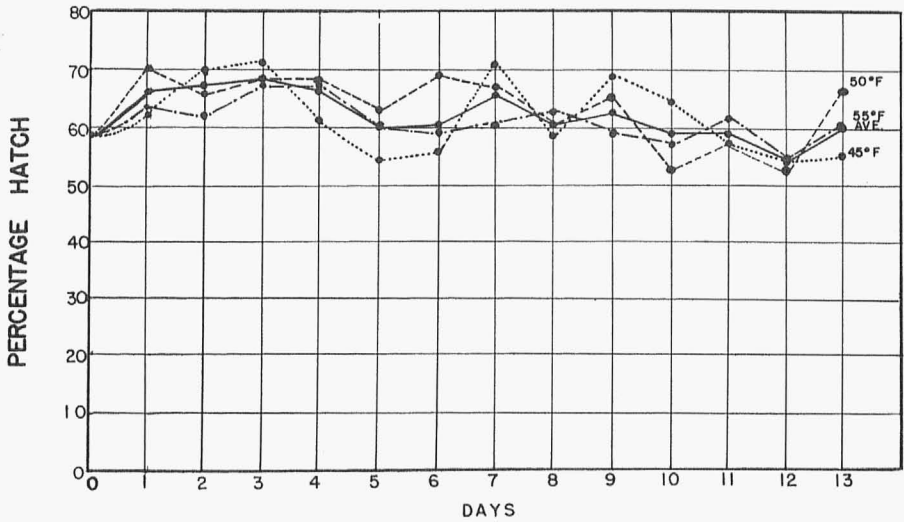


Figure 4. Optimum Temperature for Holding Eggs for Hatching.

Table 8. Optimum Temperature for Holding Eggs for Hatching.

Days Held	Holding Temperatures			
	45 F.	50 F.	55 F.	Ave..
	per cent hatch			
0	59.9	59.9	59.9	59.9
1	63.1	70.8	64.4	66
2	70.8	66.4	63.9	67
3	72.6	68.2	67.0	68.9
4	62.4	68.6	67.3	66
5	55.6	64.4	60.0	60
6	56.0	69.4	59.8	61.7
7	71.8	67.6	60.2	66.2
8	59.2	61.4	63.8	61.5
9	69.0	65.0	59.0	64.1
10	65.4	52.8	57.9	59
11	57.8	57.3	62.3	59
12	55.9	53.9	55.6	55
13	56.2	66.0	60.9	60.1
Average	63.2	63.3	61.0	62.5

ing 6.8 per cent for those eggs held for the 13-day period (Table 9, Figure 5).

Table 9. Relation of Holding Temperature Before Incubation to Hatchability of Eggs. New Hampshire Eggs Laid Between April 21 and July 13, 1949.

Days Held	Holding Temperatures		
	32° F.	40° F.	45-50-55° F. Ave.
	per cent hatch		
0	59.9	59.9	59.9
1	62.5	69.7	66
2	65.0	70.4	67
3	35.7	64.8	68.9
4	50.0	65.6	66
5	0	50.5	60
6	0	51.1	61.7
7	0	41.3	66.2
8	0	36.6	61.5
9	0	24.0	64.1
10	0	40.0	59
11	0	18.5	59
12	0	21.1	55
13	0	6.8	60.1
Average	16.2	43.4	62.5

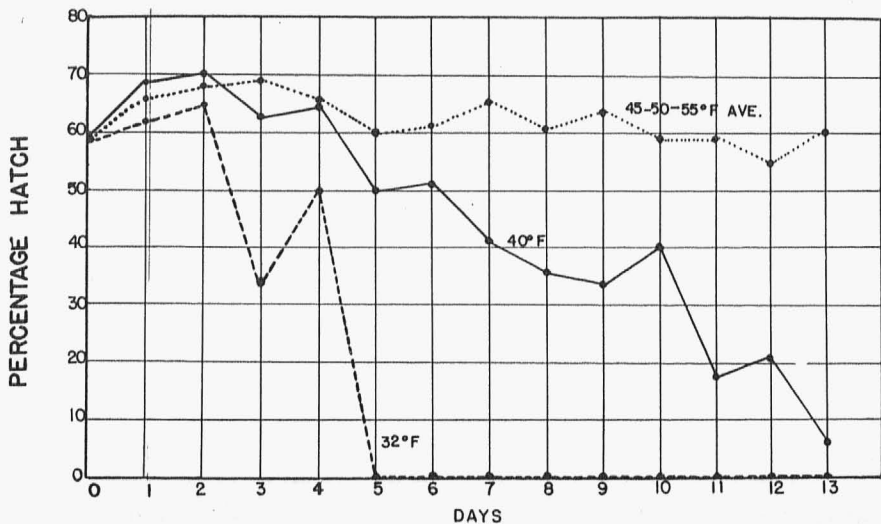


Figure 5. Effect of Holding Temperatures Below 45° F. on Hatchability.

Holding hatching eggs at temperatures above 55° was extremely harmful depending upon the temperature at which the eggs were held (Table 10, Figure 6). Short time holding at 60° and 70°F. did not seriously effect the hatchability. At 90° the effect of high temperatures was evident for eggs held as briefly as 2 days. Eggs held at this temperature over 6 days failed to hatch. At 80°F. a gradual decline in hatchability appeared for eggs held for more than 4 days. Less than 1 per cent of the eggs held for 13 days hatched. Eggs held at 70°F. hatched very well if not held over 7 days. In fact, eggs

Table 10. Relation of Holding Temperature Before Incubation to Hatchability of Eggs. New Hampshire Eggs Laid Between April 21 and July 13, 1949.

Days Held	Holding Temperatures				
	45-50-55° F. Ave.	60° F.	70° F.	80° F.	90° F.
	per cent hatch				
0	59.9	59.9	59.9	59.9	59.9
1	66	59.2	59.6	68.8	72.5
2	67	63.0	60.6	62.0	58.3
3	68.9	61.5	64.9	64.6	57.1
4	66	56.7	62.0	57.9	46.3
5	60	58.5	54.3	50.5	22.5
6	61.7	56.0	66.4	50.5	18.9
7	66.2	62.0	59.5	44.4	0
8	61.5	59.0	50.0	37.6	0
9	64.1	57.4	47.5	26.7	0
10	59	49.6	36.5	25.5	0
11	59	47.0	38.8	12.8	0
12	55	44.5	36.3	7.1	0
13	60.1	47.1	32.7	.9	0
Average	62.5	55.0	50.2	39.4	20.9

held at 70°F. for 7 days or less hatched as well as did the controls. When eggs were held for more than 7 days hatchability underwent a marked decline. The eggs held at this temperature for 13 days experienced a hatchability of 32.7 per cent.

The eggs held at 60°F. maintained their hatching power quite well if not held over 8 days. If held more than 8 days an appreciable decline in hatchability occurred.

The harmful effects of exposure of hatching eggs to temperatures below 45°F. or above 55°F. for periods over 7 days as compared

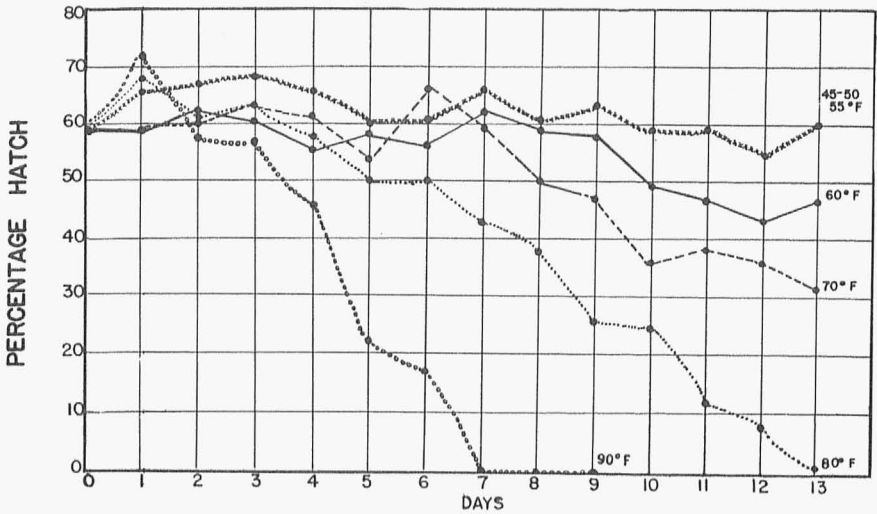


Figure 6. Effect of Holding Temperatures Above 55°F. on Hatchability.

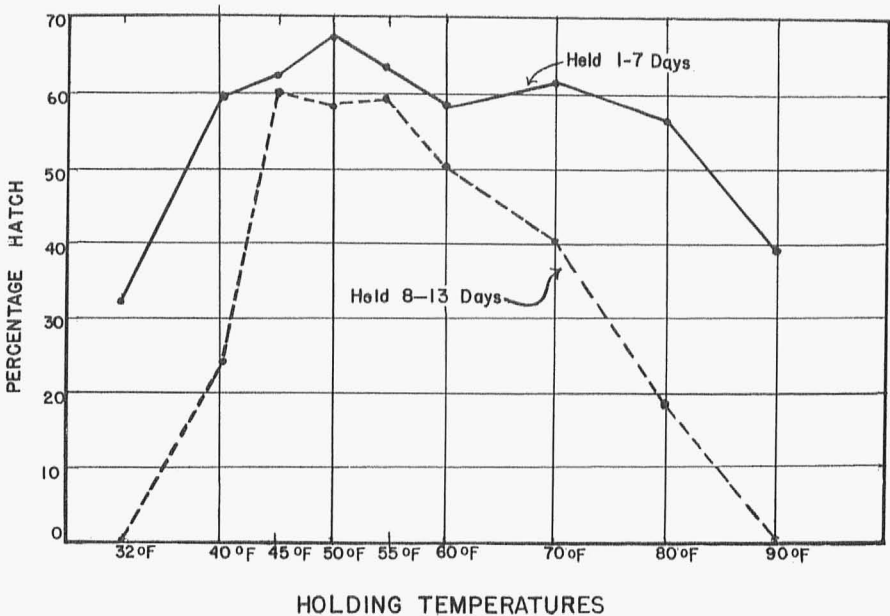


Figure 7. Harmful Effects of Exposing Eggs to Temperatures Below 45°F. or above 55°F. for periods of over 7 days as compared to those held less than 7 days.

to those held less than 7 days is shown in Figure 7. Eggs held at 32°F., 80°F. and 90°F. for 7 days or less were inferior in hatching power to those held at temperatures ranging from 40° to 70°F. On

the other hand only those eggs held at 45°F., 50°F. or 55°F. showed satisfactory hatchability if held for more than 7 days. Even eggs held at those temperatures if held for 7 days or more showed slightly less hatchability than did those eggs placed in the incubator within 7 days after being laid. It is evident that age of the hatching egg is an important factor, especially if held at high or low temperatures.

#### The Quality of Chicks Hatched from Eggs Held at Different Temperatures

There were not only great differences in the number of chicks hatched from eggs held at different temperatures but there were also differences in the quality of the chicks. Chicks hatched from eggs held at 45°F., 50°F. and 55°F. were bright-eyed, vigorous, and well fluffed with few second grade chicks. Those hatched from eggs held at higher temperatures tended to be dull, listless, poorly fluffed and of lower quality.

#### The Breed May Influence the Ability of Eggs to Retain Their Hatchability When Held at Higher Temperatures

Table 11 shows the effect of the holding temperature on hatchability of New Hampshire eggs, White Plymouth Rock eggs and eggs from White Plymouth Rock females mated with New Hampshire males.

Using the percentage hatch of eggs set the day laid as a control and comparing this percentage with the percentage hatch of total eggs held 1 to 13 days at the different temperatures, we find the New Hampshire eggs hatched best when held at 45°F. and 50°F. White Plymouth Rocks hatched better when held at 60°F. Eggs from White Plymouth Rocks mated with New Hampshire males hatched best when held at 50°F., but maintained their hatchability well even when held at higher temperatures.



Table 11. Effect of Holding Temperature on Hatchability of Eggs Laid by New Hampshires, White Plymouth Rocks, and New Hampshire and White Plymouth Rock Crosses.

Holding Tempera- tures	New Hampshires			White Plymouth Rocks			New Hampshires X White Plymouth Rocks		
	No. Eggs Set	% Hatch All Eggs	% Hatch of Controls	No. Eggs Set	% Hatch All Eggs	% Hatch of Controls	No. Eggs Set	% Hatch All Eggs	% Hatch of Controls
Controls Set									
Day Laid	828	59.9	100.0	226	73.1	100.0	72	78.7	100.0
32° F.	218	16.2	27.0	68	16.2	22.0	5	20.0	25.4
40° F.	1193	43.4	72.5	346	40.2	55.0	72	58.7	74.6
45° F.	1411	63.2	105.3	393	69.2	94.7	119	66.7	84.8
50° F.	1419	63.3	105.7	365	69.9	95.6	146	87.0	110.5
55° F.	1413	61.0	101.8	364	70.1	95.9	139	77.0	97.8
60° F.	1399	55.5	92.7	369	74.8	102.3	135	76.5	97.2
70° F.	1416	50.2	83.8	372	67.5	92.3	103	77.7	98.7
80° F.	1424	39.4	65.8	385	57.9	79.2	79	73.8	93.8
90° F.	456	20.9	34.9	127	26.8	36.7	25	16.0	20.3

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