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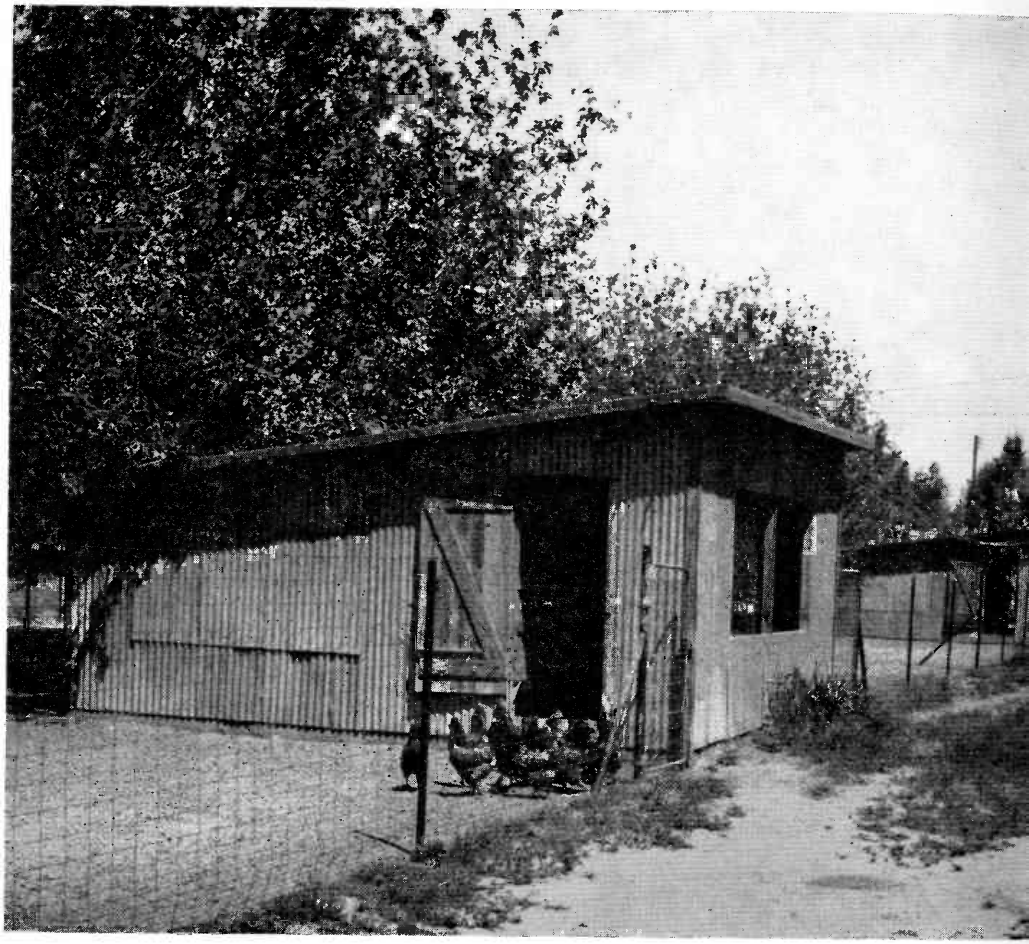
ENVIRONMENTAL FACTORS AND THEIR EFFECT ON THE NATURAL EGG CYCLE



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University of Arizona, Tucson

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By H. B. Hinds

INTRODUCTION

Protection and the regulating of environmental conditions are the primary purposes of poultry housing. Formerly the objective was to provide protection against the elements. Today, such factors as temperature, light, humidity, ventilation, space, and sanitation are given consideration.

The literature contains numerous references as to the effect of the various factors listed above on the productivity and activity of the hen. For example, light is an important factor in layer management. Probably there are elements in the light rays that stimulate the bird, thereby playing an important role in production and health. In addition continuous light allows the bird to eat and drink at will. Many poultrymen are now using this system with their flocks. According to Heywang (1) restricting the amount of feed intake caused a decrease in the total average number of eggs produced but did not affect the average size of the eggs laid by the fowls or the average body weight. Parkhurst (2) reports finding no significant difference in the weight of eggs laid by White Leghorn pullets in lighted and unlighted pens. Bruckner (3) found that the use of a constant supply of heat resulted in an increased winter egg production of birds in heated pens over those in unheated pens. Also, that when a mean temperature of 50 degrees Fahrenheit was maintained there was a stabilizing effect on winter egg production in that declines in rate of lay following cold periods were prevented. He further reported that eggs produced by the birds in the heated pens were smaller during the winter months than those produced by the birds in the unheated pens.

Bennion and Warren (4) showed that the mean egg weight declined sharply when temperature was above 85 degrees Fahrenheit. Also, that egg size declined much more rapidly under high temperature than it increased when temperatures were lowered. Extremes in temperature were followed by a decline in production. They also reported the period for maximum egg size was February until May, with only small fluctuation during this time.

The semiarid area of the Southwest presents many problems for the poultryman. The climate is such that the comfort of the bird is of major importance, if profitable production is to be obtained. The environmental factors, therefore, take on added significance as to their effect on the natural egg cycle. Poultrymen are becoming more impressed with this fact and have

devised various methods of making the surroundings as comfortable as possible. Results of their efforts have not in all cases been satisfactory nor conclusive. A test was therefore outlined to include the following objectives.

OBJECTIVES

1. The effect of light and temperature variations during the twenty-four-hour period on the weight and number of eggs.
2. The effect of seasonal variations in temperature and length of daylight on the rate of lay.
3. Continuous lighting and its effect on the distribution of lay over the twenty-four-hour period.
4. Constant conditions of light, temperature and humidity as they affect egg size, food consumption, mortality, and health of the bird.

PROCEDURE

Rhode Island Red pullets were used in these tests. The birds were approximately six months of age at the beginning of each trial. They were hatched at the same time and were equalized as to physical condition and breeding. In so far as possible full sisters were employed and were divided equally between the two lots.

All birds were housed in individual hen batteries (Plate I). A battery unit was composed of three tiers, each containing four individual compartments. Each compartment was 17x17 inches by 18 inches high. The over-all dimensions of a unit was 40 inches in length, 38 inches in depth, and 72 inches in height. Each room was 7x10 feet by 10 feet high.

One unit of twelve birds was kept in a room lighted only by daylight coming through an open window and screen door. These birds were exposed to the extremes of hourly and seasonal temperatures.

The other group of twelve birds was kept in an insulated room where the temperature and light were constant. A thermostatically controlled heating element prevented the temperature from falling below 60 degrees or going above 80 degrees Fahrenheit. Fresh air was admitted around the heating unit and reached the birds at the desired temperature. A ventilating fan placed in the opposite wall served as an outlet. In the summer months air entered the room through an evaporative cooler and was expelled by the ventilating fan. In this manner the temperature was under constant control and was not subject to daily or seasonal variations. Light was supplied by two light bulbs that burned constantly.

Birds for both lots were reared on the floor and placed in the cages about two weeks before the tests were begun. In preliminary trials battery birds were used but since floor-reared pullets soon adapted themselves to close confinement this method was adopted.

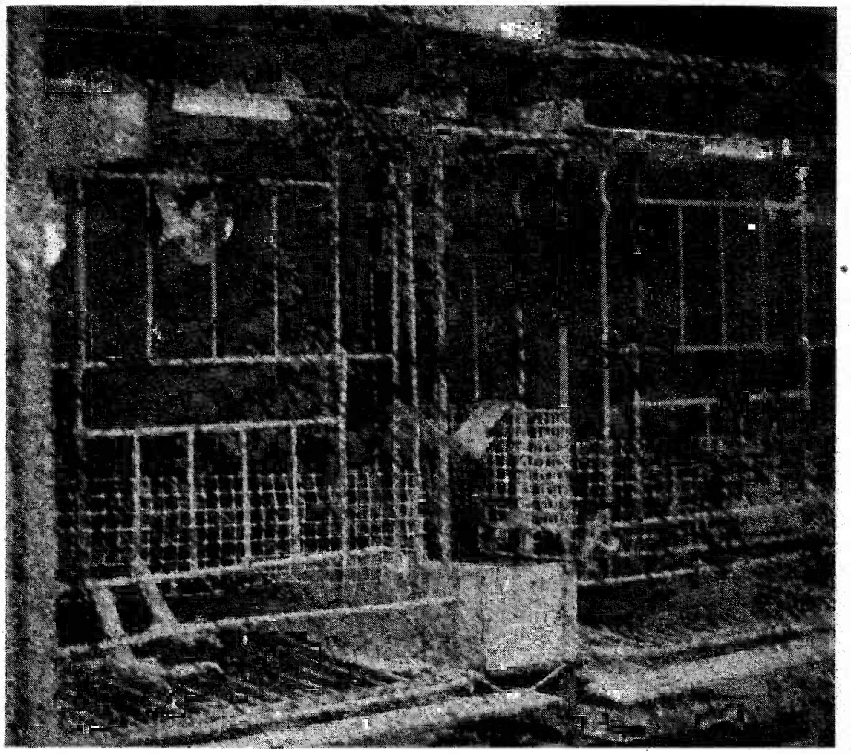

Plate I.

DESIGN OF RECORDING EQUIPMENT

In order to determine the time of lay of each bird over the twenty-four-hour period it was necessary to design a recording apparatus. Since each bird was in a battery compartment the crediting and weighing of the eggs laid by the individual was a simple matter. The recording of the actual time of lay, however, presented many problems. These were eventually overcome and Figure 1 illustrates the type of apparatus used in this phase of the experiment.

The individual hen battery is represented by (A) in the above sketches. In order to facilitate the prompt recording of the egg a special floor was installed and the angle increased over that of a standard unit. The floor (B) slopes so that the egg (C) when laid rolls to the front (D), over the lever (E), into receptacle (F).

Lever (E) has a spring hinge and the weight of the egg (C) will force lever (E) down, closing electrical contact points (G). As soon as the egg rolls to the floor of the receptacle the contact points will open again and the circuit will be broken.

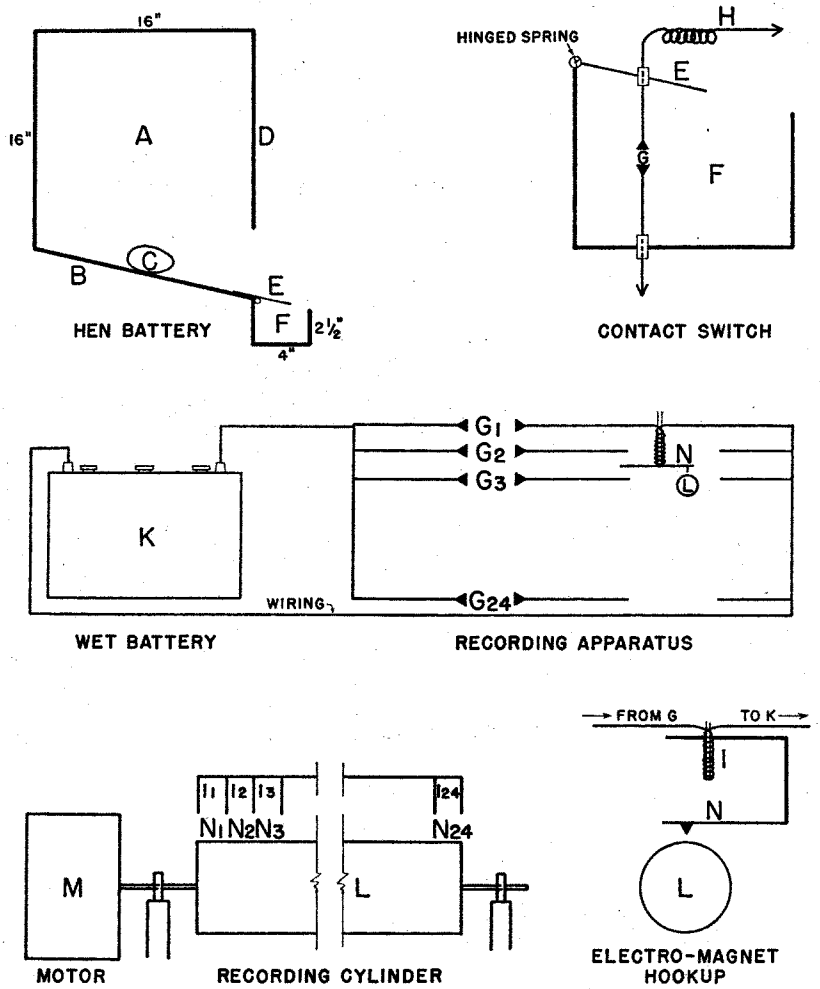

Figure 1.

The wire (H) from each hen compartment goes to the central recording device where there is an electromagnet (I) and a writing arm (N) for each hen. The current for each circuit is supplied by the same wet storage battery (K). The writing arm (N) records the time the egg is laid on a single chart turned on a cylinder (L) driven by clock (M). The chart on which the recordings are made is placed upon the cylinder. This cylinder is 12x24 inches, the long side being the circumference. Each ½ inch on the 12-inch side is allotted to a single hen. The long side is marked in inches and quarter inches, each inch representing an hour in the twenty-four-hour period.

The closing of the contact points at the time that the egg is laid and rolls over the lever results in a magnetic field being set up. This pulls the writing arm into contact with the magnet where it is held until the circuit is broken due to the passing of the egg into the receptacle. On release the writing arm rebounds against the recording cylinder, thereby recording the time of lay.

The eggs were gathered twice daily and weighed on a gram scale, the weight being recorded to 1/10th gram.

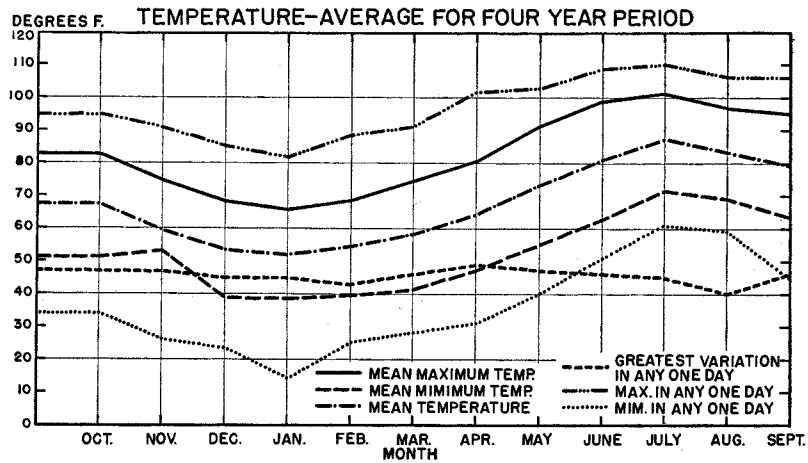

Figure 2.

TEMPERATURE

Laying hens are adversely affected by sudden temperature changes as well as by prolonged periods of extremes of heat or cold. Such changes usually result in a decrease in numbers as well as size of eggs.

Figure 2 shows the temperature that was recorded by the University Weather Bureau for the four-year period. The mean maximum varied from a low of 65 degrees Fahrenheit in January to a high of 101 degrees in July. The mean minimum ranged from 38 degrees Fahrenheit in January to 71 degrees in July. During that same period the absolute maximum was reached in July, with 110 degrees Fahrenheit. The lowest minimum for any period was in January when a low of 14 degrees was recorded. It should be noted that the greatest daily variation in temperature for any one day for the entire period was quite uniform. Furthermore, there is a considerable spread in daily temperatures to which the bird must submit when housed in the usual manner. The cumulative effect of such temperature changes on the number and size of the eggs, the food consumption and mortality will determine the feasibility of air conditioning poultry houses in southern Arizona.

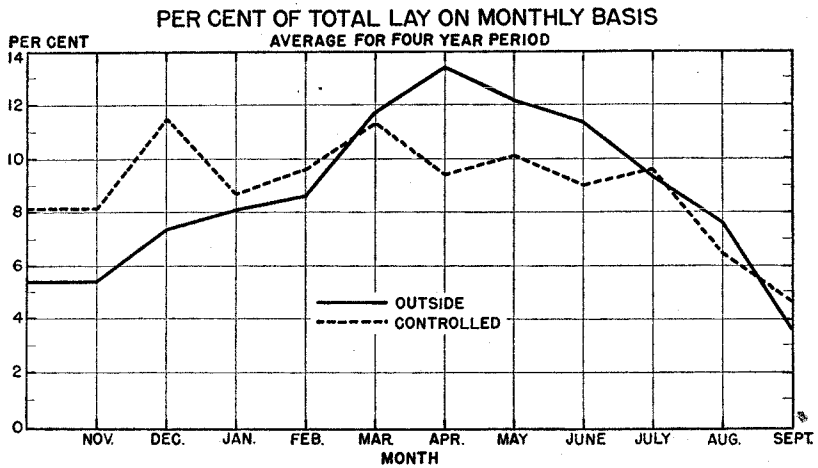

Figure 3.

DISTRIBUTION OF LAY ON A MONTHLY BASIS

Figure 3 gives the percentage of the total number of eggs that were laid each month. All records are on an eleven-month basis due to the necessity of getting new birds accustomed to cage management before the start of a new test.

The group of birds that were housed in the room in which the temperature, light, and humidity was under control laid at a very uniform rate from November through July. In each of the four years the monthly rate of production was considerably lowered in August and September. Since this is the end of the laying year a decline is to be expected, even in air-conditioned houses.

The outside lot was quite erratic in their distribution of lay on a monthly basis. They were affected by temperature variations to which they were subjected. In the fall, winter, and late summer months production was low, while the spring and early summer period found these birds laying at a high rate.

DISTRIBUTION OF LAY OVER THE TWENTY-FOUR-HOUR PERIOD

The distribution of lay over twenty-four hours is set forth in Figure 4. The day was divided into eight periods of three hours each, beginning at 12 o'clock noon. From 6 P. M. to 6 A. M. was considered the period of darkness. Normally this would be the time of inactivity for birds confined to the outside cages. However, at certain seasons of the year these pullets were able to see and eat until approximately 7 P. M. Apparently this additional time of activity did not influence the distribution of lay to any appreciable extent.

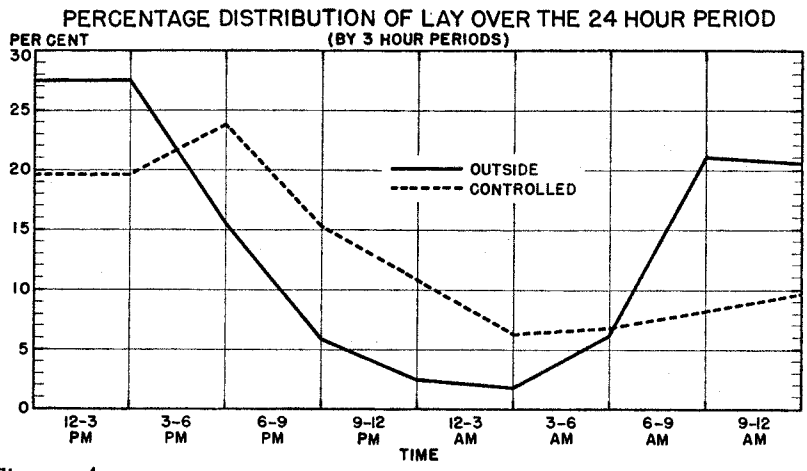

Figure 4.

It has been contended that continuous light has a stimulating effect on the hen, aside from affording more time to eat, thereby resulting in greater egg production. In the tests under discussion continuous light did not increase the number of eggs but materially influenced the time of lay.

During the period of darkness (6 P. M. to 6 A. M.) the group under controlled conditions with continuous light laid 38.80 per cent of their total production. In the same period the noncontrolled lot laid 16.19 per cent of their eggs.

From 6 A. M. to 3 P. M. the birds under regulated environmental conditions produced 37.4 per cent of their total lay as compared to 68.21 per cent for the nonregulated lots. In the rate of lay for the 3 P. M. to 6 P. M. period, the controlled group had 23.8 per cent and the noncontrolled birds 15.6 per cent of their lay between these hours.

It is interesting to note that under the conditions of this series of tests the birds confined to hen batteries without artificial light produced approximately one-sixth of their eggs during the period of darkness. This is in direct contrast to birds handled in the orthodox manner where the number of eggs laid during the night are relatively few. In most cases such eggs are soft shelled while those recorded from the cages were normal. Thus it appears that some factor, possibly a lack of exercise in cages, may affect the physical composition of hens to the extent that the normal time of lay is disrupted.

EGG WEIGHTS

The average weight of eggs is set forth in Figure 5. Normally egg size increases as pullets mature. When this increase is retarded by environmental factors such adverse conditions must be of such a nature as to counter this natural tendency.

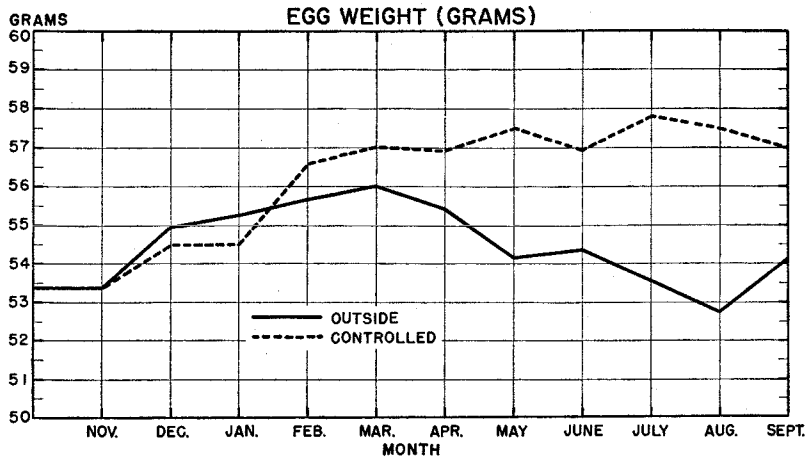

Figure 5.

Data herein presented indicates that high temperatures, if long sustained, will halt and retard egg size. Such conditions prevail in southern Arizona at certain seasons of the year. During these periods the nights remain hot until late in the evening although some relief is afforded the birds before morning when the air cools. This is merely a temporary respite and the effect on egg size is not of major importance as shown by the continued decrease in egg weight as day temperatures increased.

The idea of hen exhaustion has been advanced as one of the probable reasons why egg size decreases after the hen has been in production for a long period of time. Since this period in the case of pullets in Arizona would normally come during the hot summer months some poultrymen assume that nothing can be done to prevent this drop in egg weight. In the case of the controlled lots this decline did not occur so it can be assumed that hen exhaustion was not a factor in egg size in these tests.

The minimum temperatures that were encountered did not influence the size of the eggs.

The eggs laid by the controlled groups were very uniform in weight. The increase in size was gradual, but consistent, for the year. On the other hand, the weight of the eggs produced by the outside group showed considerable variation. These changes followed quite closely the maximum temperatures for the period. The maximum egg size was secured during March and the minimum in August. The mean temperature for March was 58 degrees Fahrenheit with the maximum of 91 and a minimum of 28 degrees Fahrenheit. For August a high of 106 degrees was reached with a low of 59.5 degrees Fahrenheit. The mean was 83.5 degrees. The highest recorded temperature for any one day was in July, when 110 degrees Fahrenheit was reached. The mean for this month was 87 degrees Fahrenheit.

Egg size was declining rapidly with the high temperatures of June and July and reached the lowest level in August. It appears that some time will elapse between the beginning of high temperatures and the period when the minimum size is reached, although a gradual loss of size will follow sustained high temperature. An accelerated rate of decline will result if sudden high temperatures are encountered.

FEED CONSUMPTION AND EGG PRODUCTION

The amount of feed consumed per bird together with the number of eggs laid and the pounds of feed required to produce a dozen eggs are given in the table below:

Year	Environment	Feed consumption per bird (lb.)	Av. no. eggs per bird	Feed per doz. eggs. (lb.)
First	Outside	60.54	116.98	6.21
	Controlled	59.66	95.88	7.46
Second	Outside	63.37	139.14	5.44
	Controlled	62.92	130.61	5.78
Third	Outside	66.82	149.83	5.44
	Controlled	65.21	124.07	6.26
Fourth	Outside	68.62	140.83	5.85
	Controlled	66.51	134.23	5.94
Average	Outside	66.06	140.09	5.66
	Controlled	63.32	121.16	6.29

The total annual egg production per bird was consistently higher in the outside cages. When the month of lay and the market value of the eggs are considered, the gross return per bird is approximately the same for both groups.

The outside lot consumed about 4 per cent more feed per bird than did the controlled group. Since the amount consumed by the inside lot closely approximates that of the outside birds it appears that continuous light, while affording more opportunity to eat, did not result in greater feed consumption or less feed per dozen eggs.

The feed required per dozen eggs was 5.66 pounds in the outside and 6.29 pounds in the controlled lots. The difference of 0.63 pounds represents 10 per cent less feed needed to produce a dozen eggs in the outside cages. In the first year of the test production was quite low in both lots but noticeably so in the inside cages. This rate of lay by these birds resulted in a requirement of 7.46 pounds of feed per dozen eggs and directly influenced the average for all the tests.

MORTALITY

The mortality in both groups was in general accord with that recorded for birds on the floor. The outside lot sustained a loss of 23.4 per cent while the controlled birds lost 17.02 per cent of

the number that began the tests. The actual number of hen days lost was 1,172 in the outside and 1,435 in the controlled cages. This loss was out of a possible 16,032 hen days. The percentage of the hen days lost due to mortality was 7.31 per cent in the outside and 8.95 per cent in the controlled groups.

The number of birds and the time of death in the outside cages were as follows: December, 1; January, 2; April, 2; June, 1; July, 2; and August, 4. The controlled groups sustained losses as follows: January, 3; February, 2; April, 1; and June, 2.

Even though a smaller number of birds died in the controlled cages the number of hen days lost was greater due to the time of the year the deaths occurred.

Deaths from excessive temperatures were sustained by the outside groups. In the period June through August, 63.6 per cent of the total mortality occurred.

WEIGHT CHANGES

A substantial number of birds in both lots weighed less at the end of the year than at the beginning. In the controlled cages 48.3 per cent were in this class, while the outside birds had 44.5 per cent so listed. The amount of gain or loss in weight was relatively small in the individuals in both lots.

Apparently no relationship exists between the loss of weight and the size of eggs laid by the bird. This is true in both the outside and controlled lots.

SUMMARY

This series of tests dealt with:

1. The effect of light and temperature variations during the twenty-four-hour period on the weight and number of eggs.
2. Seasonal variations in temperature and the length of daylight on the rate of lay.
3. Continuous light and its effect on the distribution of lay over the twenty-four-hour period.
4. Controlled environmental conditions and their effect on egg size, food consumption, weight changes, and mortality.

The results obtained warrant the following general statements:

1. Laying hens are adversely affected by sudden temperature changes as well as by prolonged periods of high temperatures.
2. Birds that are confined to air-conditioned houses will have a uniform distribution of lay over most of the year. Birds in nonair-conditioned houses will be erratic in their distribution of lay. Such birds will reach their peak in production in the spring months and decline rapidly as hot weather arrives.
3. A substantial number of eggs will be laid during the period from 6 P. M. to 6 A. M. by birds in batteries, subjected to continuous light in air-conditioned houses. Birds confined to batteries in nonlighted and nonair-conditioned houses will lay a much smaller proportion of their total lay during this period. The total number, however, will be much larger than in the case of birds kept on the floor under similar conditions.

4. It has been contended that continuous light has a stimulating effect upon the bird, resulting in greater food consumption with a consequently greater number of eggs. This was not the case in this series of tests.
5. A natural tendency exists for eggs to increase in size during the pullet year. Sustained high temperatures will overcome this tendency and cause egg size to decline.
6. Mortality was in general accord with that recorded for birds kept on the floor. Heat losses accounted for a major part of the mortality sustained by the outside lots.
7. Some birds in both groups weighed less at the end than at the beginning of the tests but apparently no relationship existed between the size of the egg and the loss of body weight.
8. The results obtained do not justify the use of continuous light, confinement, and controlled environmental conditions as practiced in these tests.
9. Air conditioning of poultry houses for southern Arizona will result in an even distribution of lay over the year. Larger eggs will be obtained and heat losses reduced. A system of floor management with air conditioning suggests a means of counteracting the slump in production and decline in egg size which accompanies high summer temperatures.

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ACKNOWLEDGEMENT

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