REPRODUCTION STUDIES IN THE TURKEY HEN: EGG FORMATION TIME AND THE EFFECT OF ARTIFICIAL LIGHT

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REPRODUCTION STUDIES IN THE TURKEY HEN: EGG FORMATION TIME AND THE EFFECT OF ARTIFICIAL LIGHT

by

John Henry Wolford

AN ABSTRACT

Submitted to

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ABSTRACT

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Individual egg production, body weight and feed consumption data were obtained on two varieties of turkey hens, Beltsville Small White (BSW) and Broad Breasted Bronze (BBB), following exposure to various light regimes during the growing and subsequent reproductive period. Data were also collected on oviposition time, ovulation time, egg formation time, oviduct length, clutch length and egg weight.

Feed intake, regardless of light regime or variety, increased sharply 10-14 days prior to onset of egg production; however, during the two weeks following this point, feed consumption decreased 10-30 percent. Feed consumption averaged 252 grams (.55 lbs) daily per hen for the BBB and 137 grams (.30 lbs) daily per hen for the BSW turkey hens during the reproductive period. Partial correlation values calculated for egg production, body weight and feed consumption indicate that egg production and body weight are negatively correlated; egg production and feed consumption are positively correlated and body weight and feed consumption are positively correlated in both varieties.

Ovulation in the BSW turkeys used in this study occurred 15-30 minutes after oviposition. Deposition of shell on the egg was started 11-12 hours after ovulation and the shell pigment was deposited during the last 2-3 hours the egg was in the uterus.

From the data obtained, it is suggested that the egg was in the infundibulum 15-30 minutes, in the magnum 2½-3 hours, in the isthmus 1-1½ hours and in the uterus 22-24 hours.

The average interval between successive eggs of a clutch was 26 hours and 46 minutes (BSW) and 25 hours and 48 minutes (BBB). This time interval was generally shorter between successive eggs of four and more egg clutches than between the two eggs of a 2-egg clutch.

Egg weight increased 21 grams in the BSW and 24 grams in the BBB turkeys during the experimental period (28 weeks of lay). The average egg weight was 69 and 84 grams for the BSW and the BBB, respectively.

The body weight of both varieties, regardless of light regime, increased until onset of egg production. Within 4 to 5 weeks after egg production began, body weight decreased. In the first year of the study, the birds did not regain the weight lost following the start of reproduction; however, in the second year this was not the case. In both varieties, the hens which received the restricted photoperiod during the growing period were lighter than the other groups at the time they were placed in cages (19 or 21 weeks of age) and, in general, were significantly lighter throughout the experiments.

From the data obtained it appears that either restricting or decreasing the photoperiod during the growing period will enhance the turkey's out-of-season egg production. Females which had received a photoperiod equal to that of natural daylight during the growing period (March 21 to October 10) produced their

first eggs 16 (BSW) and 20 (BBB) days later and produced significantly fewer eggs during the reproductive period than did turkey hens on either the restricted or decreasing photoperiod.

Thus, the data indicate that turkey hens can be stimulated to produce eggs during the late summer and early fall months by proper management of the photoperiod during the growing phase. However, the light treatments used in this study did not extend the length of the reproductive period beyond that which occurs under natural lighting conditions.

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INTRODUCTION

Researchers have been constantly trying to improve the reproductive performance of turkey breeder hens in order to reduce replacement and maintenance costs; but they have been impeded by the turkey's seasonal reproductive nature. The successful employment of artificial light to stimulate reproduction in chickens suggests a possible means of eliminating the seasonal reproductive problem in turkeys.

The feasibility of eliminating the turkey's seasonal reproductive nature and extending the turkey's reproductive period has led to the present study which was designed to ascertain the effects of various light regimes during the growing and subsequent reproductive period on egg production, body weight, sexual maturity, mortality, egg weight, growth rate and feed consumption of turkey hens.

In addition, the data presented on ovulation time, egg formation time, oviposition time, interval between successive eggs of a clutch, clutch length and oviduct length is intended to augment and expand the present knowledge of the turkey's reproductive cycle.

REVIEW OF LITERATURE

A number of researchers have observed that turkeys could be stimulated into early egg production by the use of artificial illumination (Albright and Thompson, 1933; Moore and Berridge, 1934; Marsden, 1936; Scott and Payne, 1937; Wilcke, 1939; Carrick, 1940; Milby and Thompson, 1942; and Davis, 1948). Other researchers (Margolf et al. , 1947; Parker, 1947; Harper, 1949; and Siegel and Howes, 1959) have reported that turkeys require from 3 to 4 weeks of artificial illumination for stimulation of complete reproductive activity. Harper (1949) also concluded that turkey hens responding most rapidly to artificial light stimulus produced the largest number of eggs during the reproductive season, although Asmundson and Moses (1950) showed that giving Bronze hens 9, 11, 12 or 13 hours of artificial light at 32-33 weeks of age delayed sexual maturity as compared to all night lights, 14 hours or 15 hours of artificial light.

Asmundson et al., (1946) demonstrated that a minimum light intensity of 2 foot candles produced maximum response of turkey hens to light; although, no significant differences in egg production of turkey hens exposed to artificial light from 7.5 and 15 watt bulbs were noted by Davis (1948). These researchers observed that housing turkey hens without lights retarded egg production. However, light intensities of 0.6, 2.5, 10.0 and 40.0 foot candles produced no significant differences in egg production, fertility, hatchability or length of breeding season of Beltsville Small White turkey hens (Marsden and Fraps, 1960).

Restricting the daily photoperiod of winter hatched poults to nine hours when 22-24 weeks of age for 3-4 weeks increased subsequent

egg production during the summer months over that of non-restricted poults (Harper and Parker, 1957, 1960). Marr et al. (1956) showed that reducing the daylength to eight hours at 14-16 weeks of age until 28-30 weeks of age increased the egg production of January hatched Beltsville Small White turkeys over that of naturally lighted controls. Ogasawara et al. (1959) showed that turkeys preconditioned with six hours of light daily for three weeks at 20 weeks of age increased egg production above that of turkeys restricted to 10 hours of light daily during this period. Turkeys which received a restricted light program for four weeks at 24 weeks of age responded more rapidly to supplemental light than did non-restricted birds which had received natural light; however, total egg production did not appear to be influenced (Leighton and Shoffner, 1961, 1 & 2). McCartney et al. (1961), Clayton and Robertson (1960) and Harper and Parker (1960) indicated that out of season egg production (summer and fall months) could be obtained by restricting light per day during the latter part of the growing period; although, the turkeys used by McCartney et al. (1961) did not maintain as high a level of egg production as did comparable groups during the winter and spring months. Decreasing the daylength given potential turkey breeders 30 minutes per week from 8 weeks to 28 weeks of age (24 hours to 14 hours) significantly delayed sexual maturity and was detrimental to egg production; however, if the declining day was discontinued at 22 weeks of age and the photoperiod restricted to six hours of light per day for six weeks, egg production was improved (Greene et al., 1962).

Shoffner et al. (1962, 2) indicated that turkey females reared on short days respond to stimulatory light levels at 24 weeks of age while those reared on long-light days required longer preconditioning

periods. A 3-week preconditioning period with six hours of continuous light per day was shown by Ogasawara et al. (1962) to be superior to ten hours of light for three weeks. Wilson et al. (1962) also showed that three weeks of light restriction at four hours is equivalent to four weeks at six hours or five weeks at eight hours. Harper and Parker (1962) demonstrated that restricting turkey females to a 9-hour daily light period for a 4-week period was as effective as either a 6- or 8-week period in terminating reproductive refractiveness.

The results obtained by McCartney (1956) indicate that turkeys reaching market age during the winter months when the days are short should be artificially lighted to provide at least a 13-hour day to attain maximum growth at 20 weeks of age for June hatched poults. A 15-week experimental period (13-28 weeks of age) with White Holland turkeys showed that birds which had received natural daylength required 4.3 percent more feed per pound of gain and weighed significantly less at 28 weeks of age. McCartney (1956) also showed that weight gains are significantly greater in Beltsville Small White turkeys under natural light conditions if the natural daylength is greater than a controlled constant 13-hour daylength. However, Smyth et al. (1961) using male turkeys found that body weight and feed consumption did not appear to be influenced by increasing or decreasing daylength 30 minutes every three days for four weeks at 10 weeks of age (decreased or increased from 15 hours of light). Shoffner et al. (1962, 1) found that turkey poults lighted 24 hours daily had higher mortality and poorer feather quality at 24 weeks of age than did those reared under short-day (6 hours) photoperiods.

That weight losses occur in turkeys shortly after egg laying begins has been shown by Asmundson et al. (1946), Scott and Payne (1941), Whitson et al.(1944) and Mitchell et al. (1962). Similar data on Bourbon Red turkeys are available in the Annual Report of the Indiana Agricultural Experiment Station (1934). Harper (1950) weighed turkeys at two-week intervals and found that Broad Breasted Bronze females gained weight until the onset of egg production; however, following the onset of egg production, body weight generally decreased.

Although results from a number of experiments (Scott and Payne, 1941; Whitson et al., 1944; Payne and McDaniel, 1958; Robblee and Clandinin, 1959; Jensen and McGinnis, 1961; and Mitchell et al., 1962) have been published on the feed intake (large turkeys, 0.44-0.68 lbs; small turkeys, 0.37 lbs.) of turkey breeder hens, none of the reports have included the individual hen feed consumption variation during the reproductive period.

Berg (1953) as cited by Kondra and Shoffner (1955) has reported that with increasing body weight, shank length and breast width, small but significant deleterious effects on egg production were noted; however, Parker and Harper (1950) obtained data which indicated that the width of breast or the body weight of Broad Breasted Bronze turkey hens bears little if any relationship to the production of either eggs or poults. Funk (1950) concluded that egg size increases with body weight and that egg production (first 8 weeks) was not related to body weight. A negative correlation between March body weight and egg production was noted by McCartney (1962); and Payne et al. (1957) observed a positive correlation between March hen body weight and egg weight.

Observations on the egg laying pattern in turkeys have indicated that a longer period of time elapses between the successive eggs laid in a shorter than in a longer clutch (Kosin, 1948); that turkeys lay 27-40 percent of their eggs before noon and 60-73 percent in the afternoon (Stockton and Asmundson, 1950; Kosin and Abplanalp, 1951; Payne and Ortman, 1956), and that there is a general decrease in egg weight within a clutch as the clutch length increases (Kosin and Abplanalp, 1951; Payne and Ortman, 1956). Research by the last two groups of scientists showed that the last egg of the clutch was smaller than the first egg of the clutch. Kosin and Abplanalp (1951) have also demonstrated that the turkeys average oviposition time is 1:45 p.m. in the afternoon and that the time required to produce an egg decreased as the length of the clutch increased. In Broad Breasted Bronze the second egg of the 2-egg clutch required 27.71 hours and the average of the last 7 eggs of the 8-egg clutches was 25.21 hours. In Beltsville Small White turkeys the figures were 27.55 and 25.13 hours, respectively. A review of the experimental procedures used in determining the egg laying pattern of the turkey shows that the turkeys used in the experiment (February-May) by Kosin and Abplanalp (1951) received artificial light from 7:00 a.m. to 6:00 p.m. and were trapnested daily at hourly intervals from 8:00 a.m. to 5:00 p.m. with the last trapping being at 8:00 p.m. The turkeys used in the experiment (February-May) by Payne and Ortman (1956) received natural light and were trapnested daily between 9:00 a.m. and 5:00 p.m. The turkeys used in the experiment (February-June) by Kosin (1948) were trapnested daily at hourly intervals between 8:00 a.m. and 5:00 p.m. Stockton and Asmundson (1950) used only natural light and trapnested

the birds until they ceased to lay.

Warren and Conrad (1942) showed that pigment deposition on the egg of the turkey occurred a few hours before oviposition. Asmundson (1939) suggested that the time the egg spent in the infundibulum and magnum was 3.25 hours, in the isthmus 1.46 hours and in the uterus 20.44 hours.

OBJECTIVES

1. To ascertain the daily feed intake of two varieties of turkeys, Broad Breasted Bronze and Beltsville Small Whites.
2. To investigate the relationship of body weight, feed consumption and egg production of turkey hens.
3. To determine the time of ovulation, oviposition and egg formation in turkey hens.
4. To investigate the effect of different photoperiods during the growing period on subsequent egg production in two varieties of turkeys, Broad Breasted Bronze and Beltsville Small White.

EXPERIMENTAL PROCEDURE

A. General Procedure - Experiments 1 and 2

Two (2) varieties[1/] of turkeys, Beltsville Small White (BSW) and Broad Breasted Bronze (BBB), were exposed to various lighting regimes during the growing and subsequent reproductive period. One group of each variety was exposed to the same photoperiod. A light intensity of more than 3-foot candles was provided at the level of the bird's eye. Weekly individual feed consumption records based on a 7-day weigh back period were obtained following placement of the birds in individual cages. Individual egg records (number, weight[2/] and time of lay) were kept throughout the production period. Trappings were made at 6:30 a.m., 7:30 a.m., 10:30 a.m., 1:00 p.m., 2:30 p.m., 4:00 p.m., 5:00 p.m., and 7:00 p.m. All birds were given feed and water ad libitum. The rations used throughout the experimental period are given in Table 1. During the growing period the birds were housed in conventional floor pens with wood shavings as the litter. Following removal from the conventional floor, the females were housed in individual cages 24 inches long, 18 inches wide and 24 inches deep with sloping wire floors. Mechanical ventilation fans, set to operate at 45°F were used throughout the entire experimental period. The pen and outside temperatures recorded after the birds were placed in individual cages (20 weeks of age, Experiment 1; 19 weeks of age, Experiment 2) are given in the appendix (Tables 1 and 2). Males were removed throughout the rearing phase because of the

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1/ The BBB turkeys were hatched from eggs supplied by a leading commercial breeder. The BSW turkeys were hatched from eggs supplied by the Michigan State University flock.

2/ Egg weights were not recorded in Experiment 1.

Table 1. Composition of rations

Ingredient	0-2 weeks	3-8 weeks	9-17 weeks	18-25 weeks	26 weeks on
Ground yellow corn	239.1	300.0	465.6	675.0	670.0
Pulverized heavy oats	40.0	50.0	60.0		
Wheat standard middlings	40.0	50.0	75.0		
Alfalfa leaf meal, dehyd. 17%	40.0	50.0	40.0	25.0	50.0
Soybean oil meal,solv., 44%	350.0	350.0	220.0	125.0	100.0
Fishmeal, red	100.0	60.0	30.0		
Fishmeal, menhaden				50.0	50.0
Meat & bone scraps, 50%	70.0	60.0	30.0	50.0	50.0
Distillers dried solubles, corn					10.0
Brewers dried yeast				10.0	10.0
Dried whey	20.0	20.0	10.0	20.0	10.0
Fat	40.0				
Ground limestone	10.0	20.0	20.0	28.0	25.0
Dicalcium phosphate				23.0	25.0
Steamed bone meal		5.0	30.0		
Salt, iodized	5.0	5.0	5.0	5.0	5.0
$MnSO_4$	0.5	0.5	0.5		
Vitamin A palminate 5000/gm	3.7	1.0	1.0		
Vitamin D 1500/gm	3.0	1.0	1.0		
Vitamin B_{12} 6 mg/lb	1.0	0.25	0.25		
Terramycin TM-5	10.0	1.0	1.0		
Choline chloride, 25%	1.0	0.4	0.4		
Methionine	0.7	0.25	0.1		
Vitamin E 20,000/lb	0.5	0.2	0.1		
Niacin	20.0 gms	20.0 gms	10.0 gms		
Riboflavin	2.5 gms	0.5 gms	0.5 gms		
Calcium pantothenate	6.0 gms				
Pro-Gen, Arsanilic	0.5 gms			6.0	
Nopcosol, M-7,vit. E/lb				1.0	
M-4, Vit. premix (Nopcosol)					7.0

necessity to prevent overcrowding. Statistical analysis of data in this dissertation was done by methods reported in Dixon and Massey, 1957 and Simpson et al., 1960.

B. Experiment 1

One hundred forty-one (141) BBB and 71 BSW turkeys were hatched on July 6, 1960. The poults were brooded for four weeks in starting batteries with continuous light. Poults from each variety were randomly divided into three groups at four weeks of age, housed on a conventional floor and given the following lighting regimes (Figure 1).

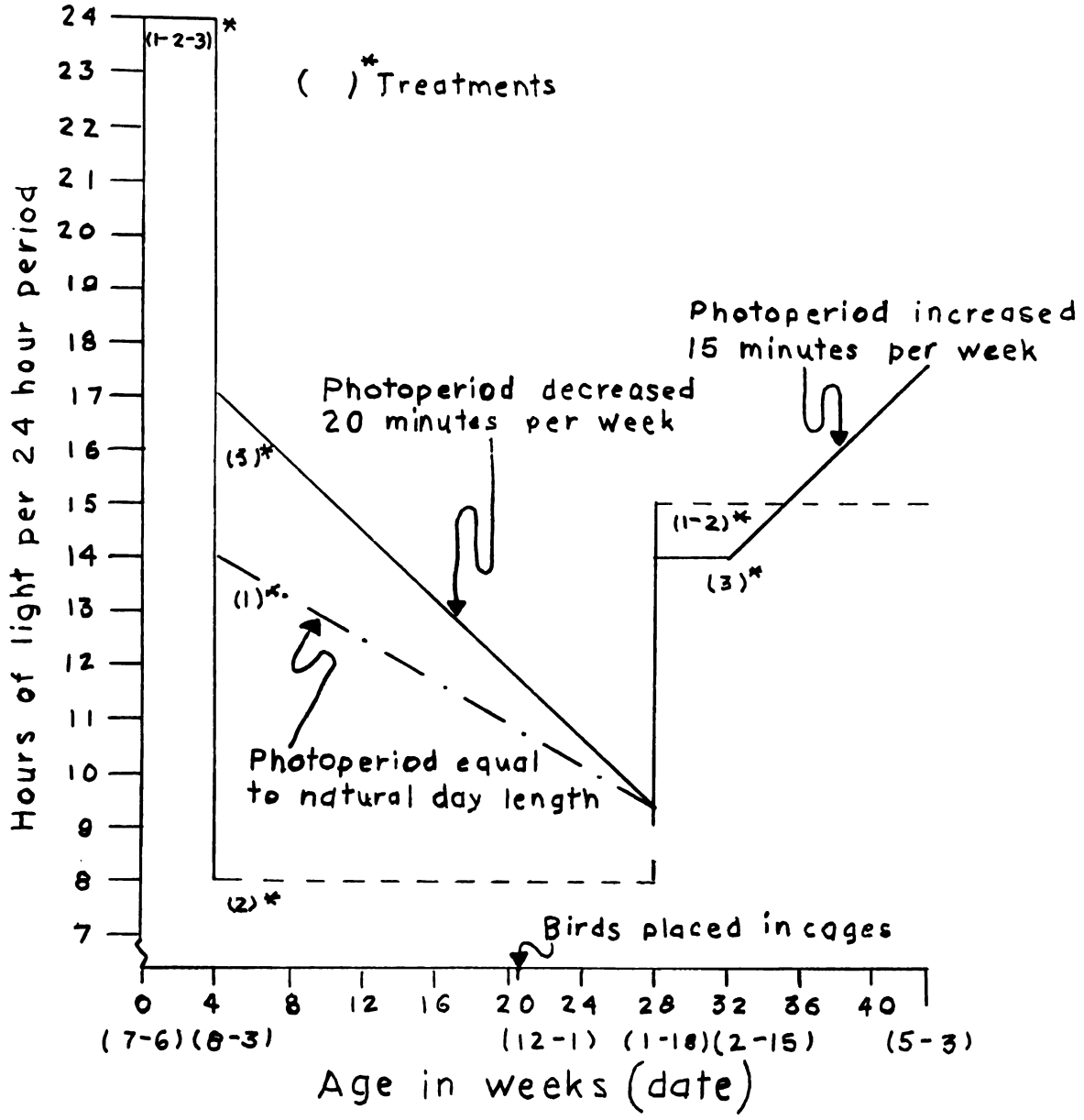
#1 - Natural light regime - A daylength equal to natural daylength was provided from 4 to 28 weeks of age; thereafter, 15 hours of artificial light were provided daily.

#2 - Restricted light regime - An 8-hour light day was provided from 4 to 28 weeks of age; thereafter, 15 hours of artificial light were provided daily.

#3 - Decreasing light regime - Starting with a daylength of 17 hours at four weeks of age, the photoperiod was decreased 20 minutes each week until the birds were 28 weeks of age. A 14-hour light day was provided from 28 to 32 weeks of age; thereafter, the photoperiod was increased 15 minutes per week until the experiment was terminated at 43 weeks of age.

Artificial lights in each pen were automatically turned on each morning at 4:00 a.m. after the birds were 28 weeks of age. The caretaker first entered the pens at 6:30 a.m. each day and the last time the caretaker entered the pens was at 7:00 p.m.

Fig. 1 - Experiment 1: Lighting regime.



each day.

At 21 weeks of age, 14 BBB and 10 BSW females were selected from each lighting regime and housed in individual cages for the remainder of the experimental period. Body weights were taken at 4, 8, 12, 16, 21, 27, 37 and 43 weeks of age. The experiment was concluded after 43 weeks following treatment with nicotine sulfate for body lice (Wolford et al., 1962).

C. Experiment 2

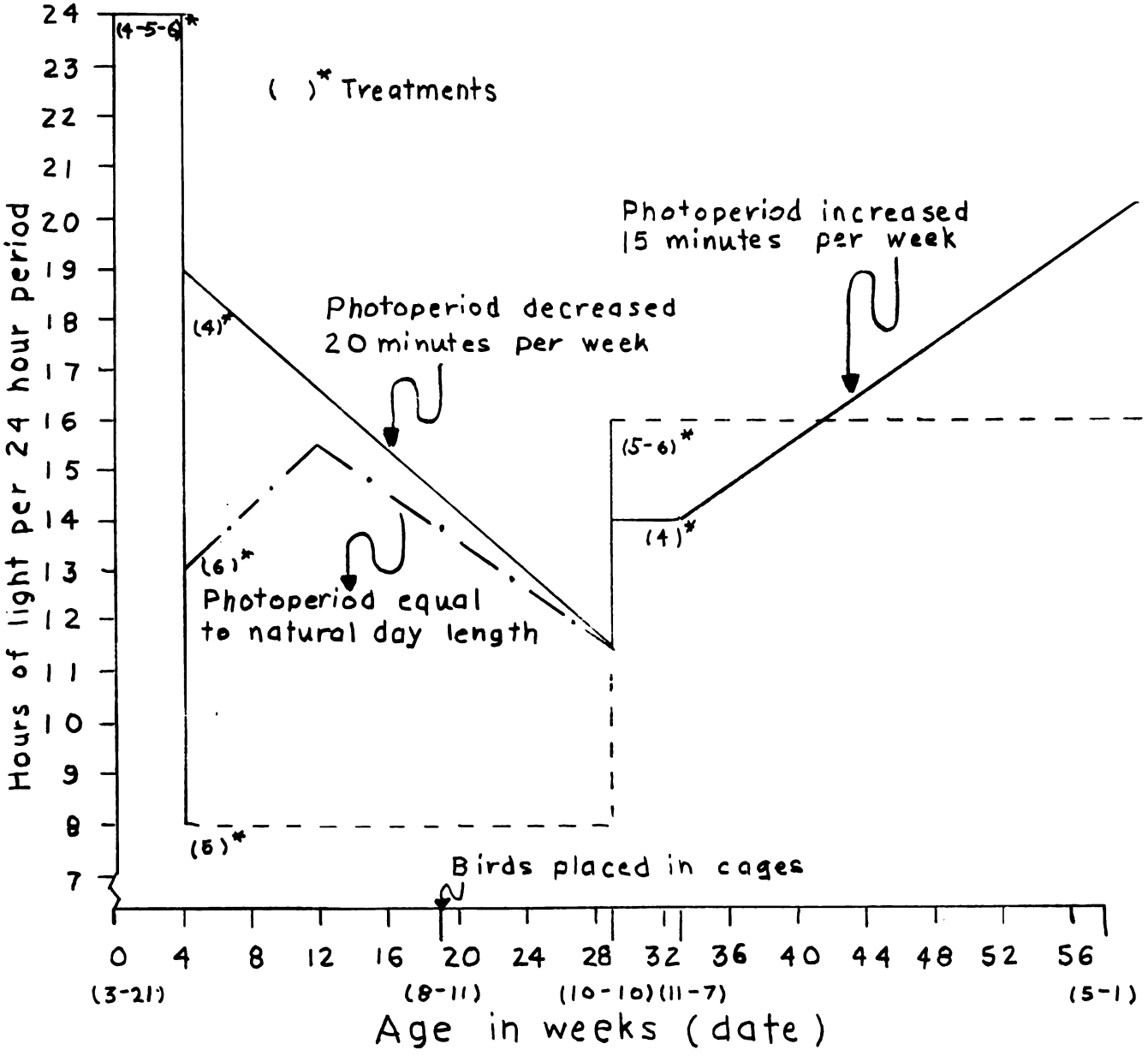
One hundred twenty (120) BBB and 141 BSW turkeys were hatched on March 21, 1961. Birds were kept on a conventional floor during the brooding and rearing phase. For the first four weeks the birds were given continuous light. At this time, poults of each variety were randomly divided into three groups and given the following lighting regimes (Figure 2).

#4 - Decreasing light regime - Starting with a daylength of 19 hours at four weeks of age, the photoperiod was decreased 20 minutes each week until the birds were 28 weeks of age. A 14-hour light day was provided from 28 to 32 weeks of age; thereafter, the photoperiod was increased 15 minutes per week until the experiment was terminated at 56 weeks of age.

#5 - Restricted light regime - An 8-hour light day was provided from four to 28 weeks of age; thereafter, 16 hours of artificial light were provided daily.

#6 - Natural light regime - A daylength equal to natural daylength was provided from four to 28 weeks of age; thereafter, 16 hours of artificial light were provided daily.

Fig. 2 - Experiment 2: Lighting regime.



Artificial lights in each pen were automatically turned on each morning at 4:00 a.m. after the birds were 28 weeks of age. The caretaker first entered the pens at 6:30 a.m. each day and the last entry was at 7:00 p.m. each evening.

At 19 weeks of age 12 BBB and 12 BSW females were selected from each lighting regime and housed in individual cages for the remainder of the experimental period. Body weights were recorded at 4, 8, 12, 16, 19, 25, 29, 31, 34, 36, 40, 44, 48, 52 and 58 weeks of age. The experiment was concluded at 58 weeks.

D. Experiment 3

Three (3) BSW turkey females were placed in individual cages, which were located in a 70-80°F temperature control room, at 28 weeks of age. The light regime at this time was 14 hours of artificial light per day. The turkeys were given feed and water ad libitum. Weekly individual feed consumption, egg production (number and weight) and feces excretion data were obtained for an experimental period of 6 weeks (29-35 weeks of age). The eggs were collected daily and placed in a 35°F cooler. The fecal material was collected daily on plastic trays, placed in a beaker, covered with aluminum foil and placed in a 35°F cooler. Kjeldahl nitrogen determinations were made on samples of feed, eggs and feces from each bird at the end of each week beginning when the hens were 29 weeks of age.

E. Experiment 4

Thirty (30) BSW turkey females were placed in individual cages at 20 weeks of age. All hens were given feed and water ad libitum. At 28 weeks of age these hens were given 16 hours of

artificial light daily (4:00 a.m.-8:00 p.m.). Individual egg production records (total number and oviposition time) were recorded throughout the experimental period. After the clutch sequence was established, the hens were sacrificed by injecting 15 cc. of atmospheric air into the heart. The times of sacrifice were 15 minutes, 30 minutes, 1 hour, 2 hours, 3 hours, 5 hours, 8 hours, 12 hours, 24 hours or 26 hours after the laying of the first egg of the clutch.

RESULTS

A. Effect of light during the rearing and growing period (4 weeks to 19 weeks or 21 weeks of age):

1. On body weight

The body weight of the females, BSW and BBB, reared under restricted light (8 hours) from 4 to 21 weeks of age was significantly lighter ($P < 0.05$) at 21 weeks of age than the body weight of turkey females reared under a decreasing or natural daylength program (Experiment 1, Table 2). However, at 19 weeks of age in Experiment 2, only the body weight of the BSW turkey hens was significantly lighter ($P < 0.01$) than the body weight of birds reared under conditions of a decreasing or natural daylength program (Table 3).

2. On feed efficiency

Feed efficiency data recorded in Tables 4, 5, 6 and 7 show that the feed required per pound of gain was less in both varieties when the turkeys were given a restricted light program (8 hours) during the rearing period. However, the total gain was less for the birds receiving the restricted

Table 2. Experiment 1. Body weight of turkey females as influenced by light during the rearing and growing period [1/]

Treatment [2/]	#1-N	#2-R	#3-D	F-Value	Std. error mean	Non-sign. P>0.05 [3/]
Beltsville Small White						
Number of birds	11	17	12			
Age in weeks						
4	1.1	1.0	1.1	0.33	± 0.07	
8	1.6	1.6	1.6	0.12	± 0.08	
12	3.5	3.6	3.5	0.08	± 0.12	
16	5.9	5.6	5.7	1.35	± 0.15	
21	7.5	6.8	7.2	3.78*	± 0.16	1-3, 2-3
Broad Breasted Bronze						
Number of birds	20	19	20			
Age in weeks						
4	1.0	1.0	1.0	0.05	± 0.03	
8	3.1	3.3	3.2	0.84	± 0.09	
12	6.7	6.6	6.5	0.48	± 0.14	
16	10.4	9.8	10.3	3.60*	± 0.17	1-3
21	13.2	12.4	13.2	3.63*	± 0.22	1-3

* Significantly different at $P < 0.05$ level.
1/ Mortality was disregarded in this analysis.
2/ N = natural light, R = restricted light, D = decreasing light.
3/ Numbers joined by a dash are non-significantly different ($P > 0.05$) by Duncan Multiple Range and Multiple F tests.

Table 3. Experiment 2. Body weight of turkey females as influenced by light during the rearing and growing period [1/]

Treatment [2/]	#4-D	#5-R	#6-N	F-Value	Std. error mean	Non-sign P>0.05 [3/]
Beltsville Small White						
Number of birds	21	20	17			
Age in weeks						
4	.9	.9	.8	3.00	± 0.02	
8	2.4	2.6	2.5	5.43**	± 0.06	5-6,4-6
12	4.7	4.7	4.5	3.08	± 0.08	
16	6.5	6.3	6.4	0.58	± 0.11	
19	7.1	6.7	7.3	6.49**	± 0.11	4-6
Broad Breasted Bronze						
Number of birds	17	14	19			
Age in weeks						
4	1.2	1.3	1.3	1.79	± 0.03	
8	4.1	4.2	4.1	0.10	± 0.27	
12	7.5	7.9	7.5	3.29*	± 0.12	4-6
16	10.3	11.0	10.6	6.86**	± 0.13	5-6
19	11.4	11.6	11.9	3.07	± 0.14	

* Significantly different at $P < 0.05$ level.
** Significantly different at $P < 0.01$ level.
1/ Mortality was disregarded in this analysis.
2/ N = natural light, R = restricted light, D = decreasing light.
3/ Numbers joined by a dash are non-significantly different ($P > 0.05$) by Duncan Multiple Range and Multiple F tests.

Table 4. Experiment 1. Feed efficiency and mortality of Broad Breasted Bronze male and female turkeys as influenced by light during the rearing and growing period

		Age in weeks				
		4-8	8-12	12-16	16-21	Total
Feed consumed (lbs)						
Treatment*	#1-N	233.5	574.5	875.5	602.0	2285.5
	#2-R	226.5	548.5	762.0	519.5	2056.5
	#3-D	232.0	450.5	818.0	675.0	2175.5
Total gain/period (lbs)						
	#1-N	107.2	193.9	223.0	110.5	634.6
	#2-R	107.3	183.5	193.2	101.1	585.1
	#3-D	99.8	168.1	200.8	110.9	579.6
Feed/pound gain						
	#1-N	2.18	2.96	3.93	5.45	3.60
	#2-R	2.11	2.99	3.94	5.14	3.51
	#3-D	2.32	2.68	4.07	6.09	3.75
Mortality (# birds)						
	#1-N	1	---	---	---	1
	#2-R	1	---	---	---	1
	#3-D	7	---	---	---	7

* N = natural light, R = restricted light, D = decreasing light.

Table 5. Experiment 1. Feed efficiency and mortality of Beltsville Small White male and female turkeys as influenced by light during the rearing and growing period

		Age in weeks				
		4-8	8-12	12-16	16-21	Total
Feed consumed (lbs)						
Treatment*	#1-N	35.0	109.5	290.5	275.5	710.5
	#2-R	35.0	94.5	232.5	213.0	575.0
	#3-D	39.5	109.5	254.5	235.0	638.5
Total gain/period (lbs)						
	#1-N	13.1	50.0	62.7	43.2	168.9
	#2-R	12.6	49.5	53.0	38.0	153.1
	#3-D	14.6	47.8	60.5	45.9	168.8
Feed/pound gain						
	#1-N	2.67	2.19	4.63	6.38	4.21
	#2-R	2.78	1.91	4.39	5.61	3.76
	#3-D	2.71	2.29	4.21	5.12	3.78
Mortality (# birds)						
	#1-N	1	---	1	2	4
	#2-R	---	1	---	---	1
	#3-D	---	---	---	2	2

* N = natural light, R = restricted light, D = decreasing light.

light program. These data also show that for the age limits of this study (Experiment 1, 4-21 weeks of age; Experiment 2, 4-19 weeks of age) the BBB were more efficient converters of the feed fed than the BSW (BBB 3.62 and BSW 3.95 pounds of feed per pound of gain).

3. On mortality

The mortality of the turkeys used in this segment of the study did not appear to be greatly influenced by lighting regime. The seven BBB poults in Experiment 1 (Treatment 3) died from coccidiosis (M.S.U. Diagnostic Laboratory). However, a greater incidence of cannibalism was noted in the turkeys receiving the non-restricted lighting regimes (Treatments 1 and 3, Table 5; Treatment 4, Table 6; Treatments 4 and 6, Table 7).

B. Effect of light during the rearing, growing and reproductive period:

1. On egg production and sexual maturity

Restricting the photoperiod in Experiment 1 to 8 hours per day from 4 weeks to 28 weeks of age significantly ($P < 0.05$) decreased the egg production of the BBB turkey hens (Table 8 and Figure 3). The total egg production of BSW hens did not appear to be influenced by any of the light regimes; however, increasing the daylength to 15 hours of light at 28 weeks of age stimulated egg production approximately 2 days earlier than did a daylength of 14 hours (Table 8). In general, the hens reached their peak production within 2 weeks after the first egg was laid (Figure 3).

Table 8. Average egg production and average date of first egg of turkey hens as influenced by light regime

Treatment 1/	Beltsville Small White		Broad Breasted Bronze	
	Eggs/hen	Date 1st egg	Eggs/hen	Date 1st egg
Experiment 1:				
#1-N	38.8	2/12/61	49.1	2/12/61
#2-R	37.0	2/14/61	31.0	2/12/61
#3-D	34.9	2/16/61	41.0	2/14/61
F-Value	0.14	3.29	7.22**	4.08*
Standard error of mean	± 4.5	± 1.0	± 3.4	± 0.7
Experiment 2:				
#4-D	67.1	11/4/61	70.5	11/6/61
#5-R	59.3	11/4/61	72.0	11/1/61
#6-N	35.8	11/20/61	57.7	11/26/61
F-Value	4.95*	7.83**	5.85**	23.96**
Standard error of mean	± 7.4	± 8.6	± 7.9	± 5.9

* Significantly different at the $P < 0.05$ level.

** Significantly different at the $P < 0.01$ level.

1/ N = natural light, R = restricted light, D = decreased light.

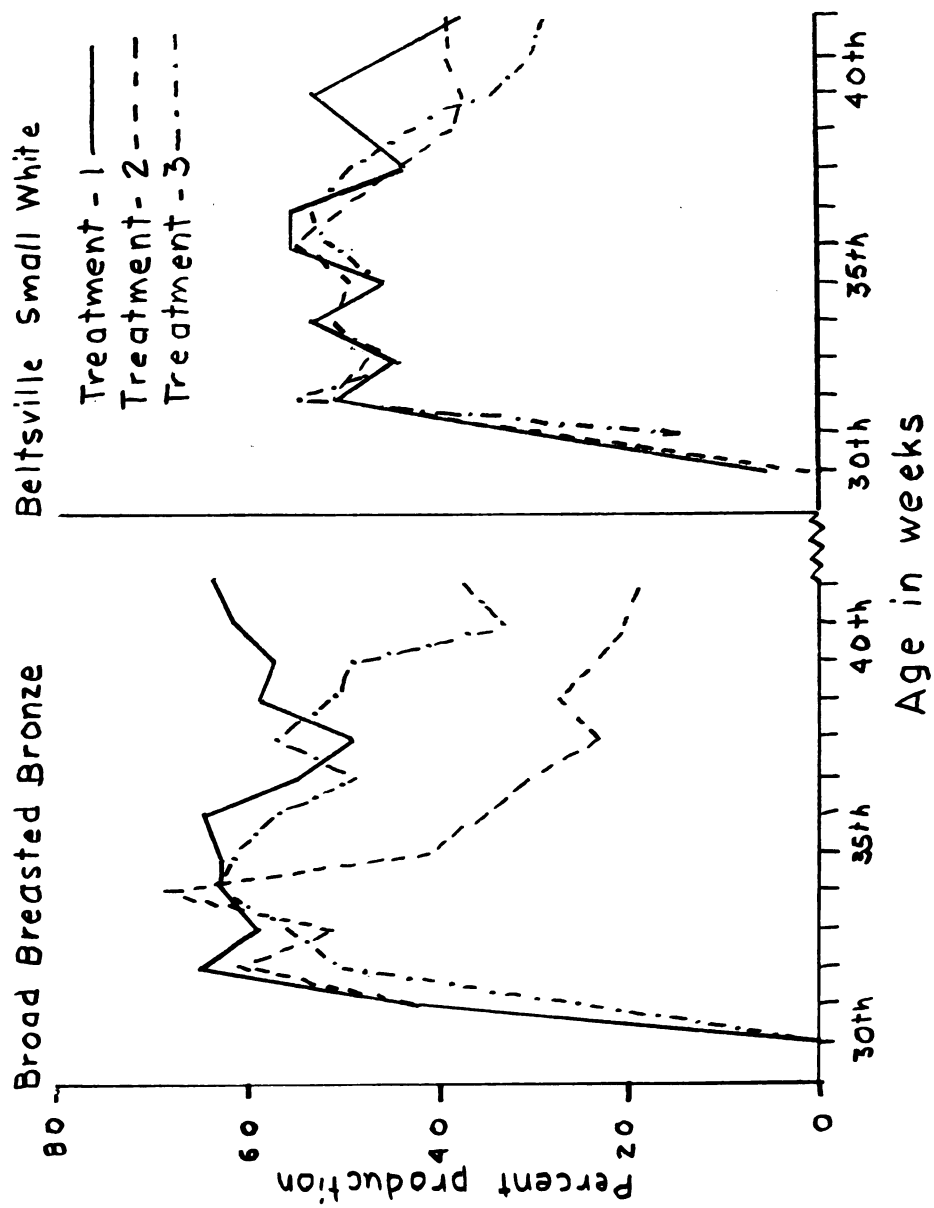


Fig. 3 - Experiment 1: Weekly production percentage.

In Experiment 2, turkey hens of both varieties receiving either a restricted (Treatment 5) or a decreasing light regime (Treatment 4) during the growing period laid significantly (BSW, $P < 0.05$; BBB, $P < 0.01$) more eggs in the reproductive period than did hens receiving an increasing and then decreasing photoperiod comparable to natural daylight conditions during the growing period (Table 8 and Figure 4). The hens on the latter regime laid their first egg 16 (BSW) and 20 (BBB) days later than did the turkey hens receiving either of the other lighting regimes. However, four BSW turkey hens receiving the increasing and decreasing photoperiod began to lay at 26 weeks of age which was approximately two weeks before the daylength was increased to 16 hours of light.

2. On body weight

The turkey hens, in the two experiments and regardless of variety, which received the restricted light program during the rearing and growing period were, in general, significantly ($P < 0.05$) lighter throughout the reproductive period (Table 9). The body weights of the turkey hens on the other two treatments in both experiments were non-significantly ($P < 0.05$) different .

3. On feed consumption

Daily feed consumption, in Experiment 1, averaged 140, 131 and 147 grams in the BSW while the BBB had a daily feed intake of 271, 230 and 271 grams, respectively, for Treatments 1, 2 and 3 during the period of 21 to 43 weeks of age (Figure 5). In Experiment 2, daily feed consumption averaged 139, 132 and

Fig. 4 - Experiment 2: Weekly production percentage.

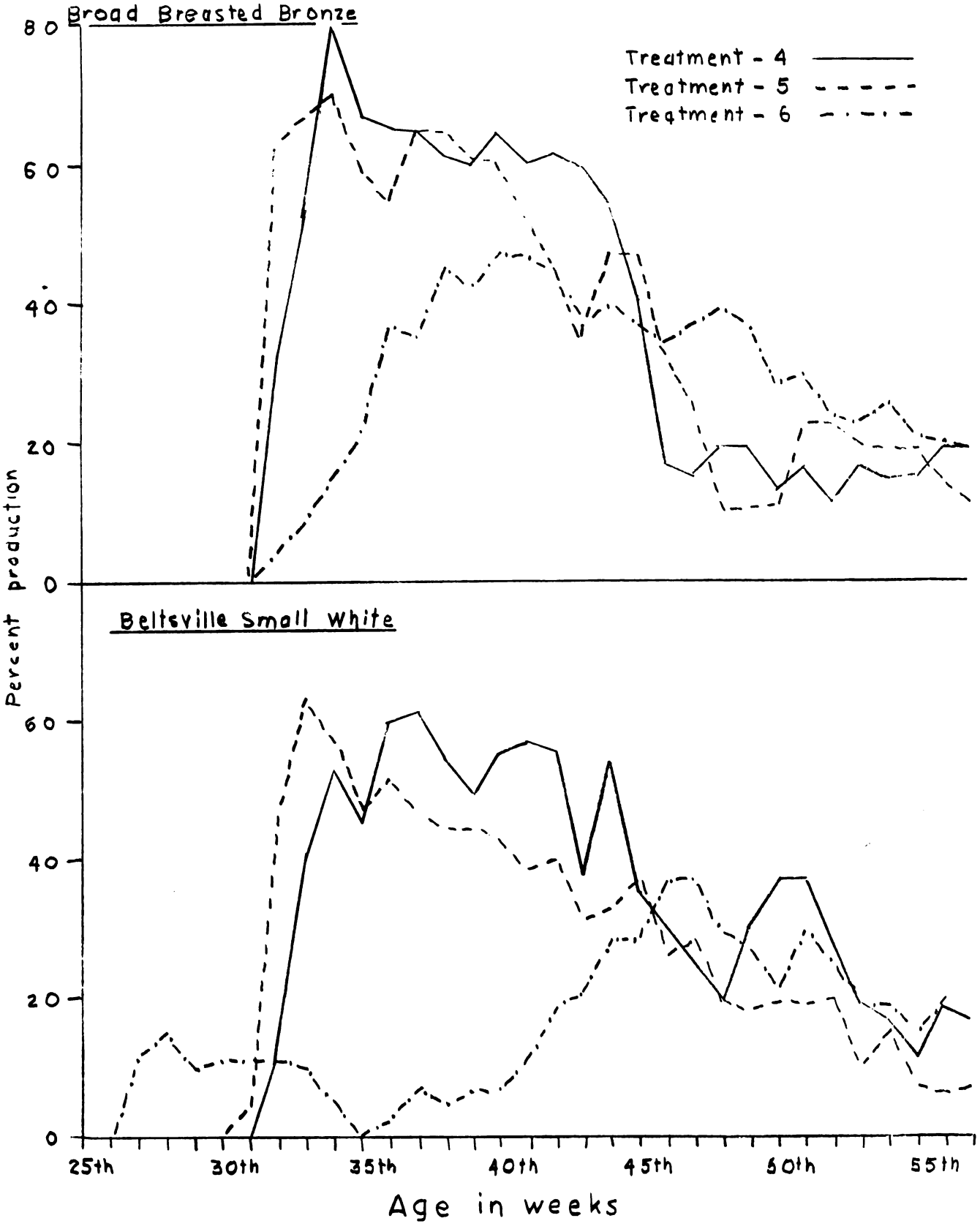
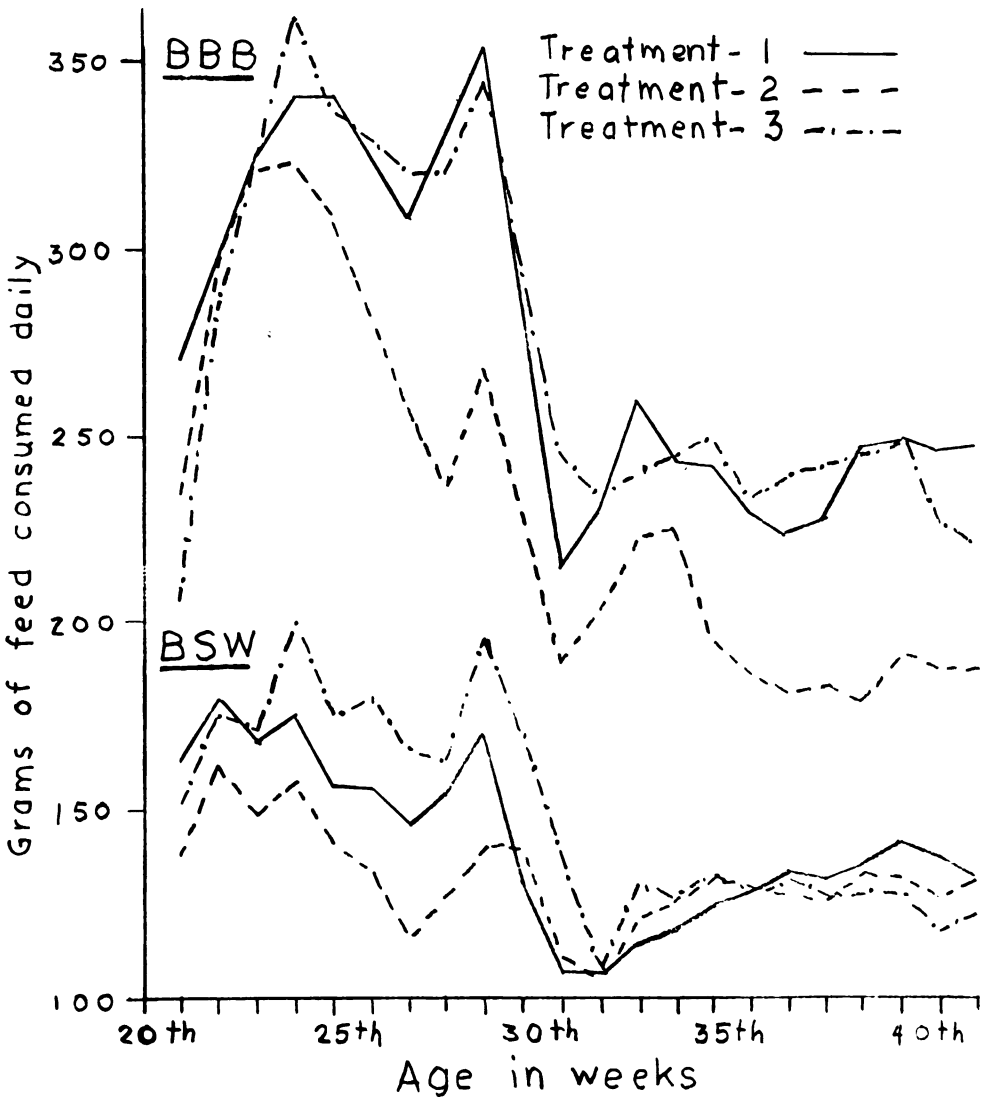


Table 9. Body weight of turkey hens as influenced by light regime

Weeks of age	Beltsville Small White					Broad Breasted Bronze				
	Treatment[1/]			F-Value	Std. error of means	Treatment[1/]			F-Value	Std. error of means
					Experiment 1					
	#1-N	#2-R	#3-D			#1-N	#2-R	#3-D		
21	7.6	7.0	7.5	12.04**	± 0.01	13.2	12.7	13.3	1.87	± 0.24
26	9.0	8.2	9.1	14.86**	± 0.13	17.9	17.1	18.2	2.68	± 0.33
31	9.9	8.9	10.3	7.21**	± 0.26	19.9	18.6	20.1	4.34*	± 0.40
37	9.1	8.2	9.4	14.12**	± 0.18	18.8	17.1	19.1	7.01**	± 0.41
43	8.7	7.7	8.8	11.59**	± 0.15	17.8	15.8	18.1	4.19*	± 0.51
					Experiment 2					
	#4-D	#5-R	#6-N			#4-D	#5-R	#6-N		
19	7.5	7.0	7.5	10.89**	± 0.09	11.7	11.6	12.1	6.00**	± 0.12
25	8.8	8.1	9.1	17.72**	± 0.17	15.3	15.2	16.3	6.36**	± 0.24
29	9.4	8.5	9.3	7.50**	± 0.16	17.0	16.6	17.3	1.29	± 0.31
31	10.3	9.3	9.7	8.53**	± 0.17	18.8	18.0	18.4	1.79	± 0.31
34	10.3	8.8	9.9	15.39**	± 0.19	18.8	17.3	19.1	8.09**	± 0.33
36	10.0	8.6	9.9	12.71**	± 0.21	18.7	16.6	19.4	13.78**	± 0.34
40	9.7	8.4	10.2	19.45**	± 0.20	18.6	16.2	19.3	18.20**	± 0.36
44	9.8	8.5	10.2	10.41**	± 0.27	18.6	16.5	19.7	15.09**	± 0.43
48	10.2	8.6	10.1	15.43**	± 0.25	18.8	17.1	20.3	24.02**	± 0.33
52	9.9	8.4	10.3	15.63**	± 0.25	18.8	17.3	20.1	19.56**	± 0.31
58	10.0	8.7	10.5	13.58**	± 0.24	19.2	17.7	20.1	6.90**	± 0.43

* Significantly different at the $P < 0.05$ level.
** Significantly different at the $P < 0.01$ level.
1/ N = natural light, R = restricted light, D = decreased light.

Fig. 5. - Experiment 1: Average daily feed consumption of Beltsville Small White (BSW) and Broad Breasted Bronze (BBB) turkey hens (21-43 weeks of age).



142 grams in the BSW and the BBB had a daily feed intake of 266, 246 and 258 grams, respectively, for Treatments 4, 5 and 6 during the period of 19 to 58 weeks of age (Figure 6). Thus, the daily feed intake was lower in the turkey hens which had received the restricted light program during the rearing and growing period.

4. On egg weight (Experiment 2)

The BBB turkey hens which had received a daylength equal to that of natural daylength (Treatment 6) produced significantly ($P < 0.01$) heavier eggs than did those hens which had received either of the other two lighting regimes (Table 10). The BSW turkey hens which had received the restricted light (Treatment 5) program during the rearing and growing period produced eggs that were significantly ($P < 0.05$) smaller than the eggs of turkey hens which had received either of the other two lighting regimes.

5. On mortality

In Experiment 1, there was no mortality after placing the birds in individual cages (21-43 weeks of age); however, in Experiment 2, one BBB and one BSW turkey hen died in the group receiving Treatment 5 after placing the birds in the individual cages (19-58 weeks of age).

C. Nitrogen balance prior to and following onset of oviposition (Experiment 3)

Body weight, feed consumption and feces output generally decreased as the birds came into production (Table 11). Total nitrogen consumed in the feed and total nitrogen

Fig. 6 - Experiment 2: Average daily feed consumption of Beltsville Small White (BSW) and Broad Breasted Bronze (BBB) turkey hens (19-58 weeks of age)

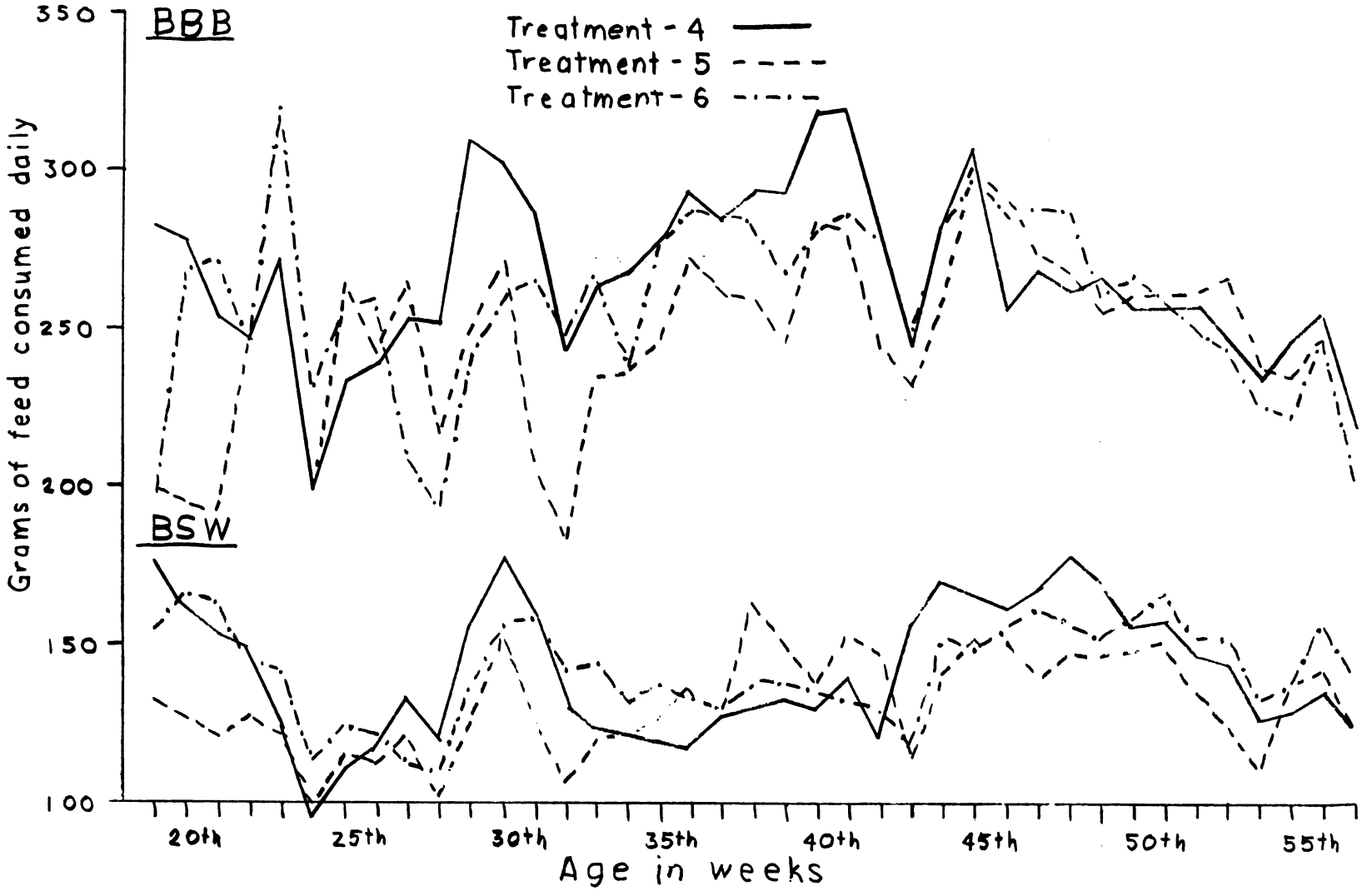


Table 10. Experiment 2. Egg weight as influenced by light regime

Treatment [2]	Egg weight #4-D	#5-R	#6-N	F-Value	Std.error of mean	Non-Sig.[1] (P > 0.01)
Broad Breasted Bronze	81.7	82.1	88.7	6.11**	± 1.56	4-5
Beltsville Small White	72.2	65.9	70.3	4.87*	± 1.45	4-6,5-6

* Significantly different at P < 0.05 level.

** Significantly different at P < 0.01 level.

1/ Numbers joined by a dash are non-significantly different (P > 0.01) by Duncan Multiple Range and Multiple F tests.

2/ N = natural light, R = restricted light, D = decreasing light.

Table 11 - Experiment 3. Nitrogen balance prior to and following onset of oviposition in the Beltsville Small White turkey hen

Age in weeks	Feed consumed per week[1] (gms)	Nitrogen content of feed (gms)	Feces produced per week (gms)	Percent nitrogen (feces)	Nitrogen content of feces (gms)	Gms. of egg produced per week	Percent nitrogen (egg)	Nitrogen content of eggs (gms)	Nitrogen balance[2] (gms)	Body wt.[3] (gms)
Bird #1										
29-30	1058	30.79	1083	2.03	21.98				+ 8.81	+ 136.2
30-31	987	28.72	1413	1.24	17.52				+11.20	+ 181.6
31-32	656	19.08	1290	1.07	13.80				+ 5.28	- 45.4
32-33	516	15.01	940	0.97	9.11	312	1.97	6.14	- 0.24	- 181.6
33-34	668	19.43	913	1.49	13.60	245	2.06	5.04	+ 0.79	- 45.4
34-35	750	21.82	915	1.71	15.64	253	2.02	5.11	+ 1.07	- 136.2
35-36	735	21.38	1002	1.76	17.63	191	2.02	3.85	- 0.10	+ 90.8
Bird #2										
29-30	1176	34.22	1102	2.00	22.04				+12.18	+ 90.8
30-31	1176	34.22	1177	2.25	26.48				+ 7.74	+ 90.8
31-32	1049	30.52	1189	2.02	24.01				+ 6.51	+ 136.2
32-33	965	28.08	901	2.16	19.46	62	1.91	1.18	+ 7.44	+ 90.8
33-34	943	27.44	1172	1.86	21.79	397	2.02	8.01	- 2.36	- 181.6
34-35	1003	29.18	1083	2.24	24.25	404	2.02	8.16	- 3.23	0.0
35-36	936	27.27	931	2.02	18.80	351	2.05	7.19	+ 1.28	0.0
Bird #3										
29-30	823	23.95	805	1.92	15.45				+ 8.50	+ 136.2
30-31	1130	32.88	1104	2.41	26.60				+ 6.28	+ 90.8
31-32	1193	34.71	1272	2.10	26.71				+ 8.00	+ 181.6
32-33	1218	35.44	1212	2.19	26.54				+ 8.90	+ 181.6
33-34	932	27.12	878	2.62	23.00				+ 4.12	+ 136.2
34-35	583	16.96	540	2.74	14.79	63	1.85	1.16	+ 1.01	0.0
35-36	812	23.62	1165	2.23	25.97				- 2.35	+ 45.4

1/ Nitrogen percentage in the feed was 2.91 percent.
2/ Positive or negative nitrogen balance per week.
3/ Loss or gain in body weight per week.

excreted in the feces decreased with the onset of oviposition. Two weeks following the onset of oviposition, weekly feed consumption increased. In general, following the onset of oviposition the BSW turkey hens were excreting more nitrogen via the feces and the eggs than they were consuming in the feed.

D. Feed consumption and broodiness

Observations on 15 hens that were determined to be broody showed that one week after first noticeable broodiness, feed consumption was only 22 percent of what the weekly average had been four weeks preceding the start of broodiness. Six weeks following the onset of broodiness, feed consumption had increased to only 35 percent of that of the four weeks prior to the broody period (Table 12).

E. Relationship of egg production, body weight and feed consumption

Feed consumption of both varieties in the two experiments increased sharply approximately two weeks (29 weeks of age) before onset of oviposition at 31 weeks of age (Figures 5 and 6). In Experiment 1, daily feed consumption decreased 32.7 percent in the BSW and 24.8 percent in the BBB during the first 14 days of egg production as compared to the 14 days prior to onset of egg production (Table 13). The daily feed consumption increased slightly after this initial drop; however, after six weeks of egg production, consumption was only 81.4 percent (BSW) and 75.3 percent (BBB) of what it had been the 14 days prior to the first oviposition. The data obtained in Experiment 2 show that daily feed consumption

Table 12. Daily feed consumption (grams) of Broad Breasted Bronze turkey females four weeks prior to and six weeks following onset of broodiness

		Feed consumption (gms)				
Weeks	Hen	41	67	106	113	Average
4		231	265	114	207	204
3		240	262	192	202	224
2		262	238	195	194	199
1		249	240	185	241	228
0		169	118	73	140	125
1		30	89	40	22	45
2		4	30	19	25	19
3		10	14	28	29	20
4		11	23	47	52	33
5		40	103	70	*	71
6		86	45	95	*	75

* Experiment concluded.

Table 13. Daily feed consumption (grams) by turkey hens prior to and following onset of oviposition

Treatment 3/	Time period 1/ A	B	C	D	E	Percent 2/ B/A	C/A	D/A	E/A
Beltsville Small White									
A. Experiment 1:									
#1-N	155	100	119	127	132	64.5	76.8	81.9	85.2
#2-R	141	104	123	129	131	73.8	87.2	91.5	92.9
#3-D	179	114	130	127	122	63.7	72.6	70.9	67.6
B. Experiment 2:									
#4-D	147	113	128	128	156	76.9	87.1	87.1	106.1
#5-R	138	111	126	129	114	80.4	91.3	93.5	82.6
#6-N	129	119	140	131	119	92.2	108.5	101.5	92.2
Broad Breasted Bronze									
A. Experiment 1:									
#1-N	312	226	249	228	246	72.4	79.8	73.1	78.8
#2-R	246	191	224	185	186	77.6	91.1	75.2	75.6
#3-D	300	227	241	233	220	75.7	80.3	77.7	73.3
B. Experiment 2:									
#4-D	288	250	276	285	243	86.8	95.8	99.0	84.4
#5-R	248	197	241	262	231	79.4	97.2	105.6	93.1
#6-N	270	245	284	286	249	90.7	105.2	105.9	92.2

1/ Time Period
- A 14 days prior to first egg.
- B 14 days following first egg.
- C 15-28 days following first egg.
- D 6th week of production.
- E 12th week of production.

2/ Feed consumption during each time period as a percentage of time period A.

3/ N = natural light, R = restricted light, D = decreasing light.

decreased 14.2 percent in the BBB and 16.8 percent in the BSW during the first 14 days of egg production (Table 13). The daily feed consumption increased after this initial drop and after six weeks of production was 94 percent (BSW) and 103.5 percent (BBB) of what it had been the 14 days prior to onset of egg production.

Regardless of light regime or variety, the turkey hens gained weight until the start of reproduction; however, body weight decreased following the onset of egg production (Table 9). In Experiment 2, body weight gradually increased as egg production decreased.

The data presented in Tables 14 and 15 show the weekly egg production of turkeys as related to body weight and feed intake. In general, the hens in the lower weight ranges, 14-16 pounds in the BBB and 7-8 in the BSW, produced fewer eggs than did hens having a body weight within the range of 16-21 pounds (BBB) and 8-11 pounds (BSW). Egg production records of the heavier hens (21.1+ lbs., BBB; 10.1-11.0 lbs., BSW) indicated that these hens produced at a high rate following onset of egg production; however, shortly after egg production commenced the production intensity decreased. Thus, the discrepancy obtained in the weekly egg production of the heavy hens between the two experiments may have resulted from the length of the reproductive period.

Partial correlation values for egg production, body weight and feed consumption suggest that egg production and body weight are negatively correlated, egg production and

Table 14 - Experiment 1. Average egg production of turkey hens at different levels of feed intake and body weight

Body wt. (lbs)	Feed consumed (gms) 100[1]	101-150	151-200	201-250	251-300	301 +	Av. for body wt.
Broad Breasted Bronze:							
14.0 - 16.0	0.1[2] (13)[3]	0.8 (5)	1.4 (14)	4.5 (11)			1.7 (43)
16.1 - 17.0		1.0 (3)	2.1 (27)	4.1 (37)	4.3 (8)		3.3 (75)
17.1 - 18.0	4.0 (1)	1.8 (5)	3.2 (33)	3.8 (48)	3.6 (15)	4.6 (3)	3.5 (105)
18.1 - 19.0		2.0 (5)	3.0 (15)	3.9 (51)	3.6 (19)	4.4 (5)	3.6 (95)
19.1 - 20.0			2.7 (12)	3.3 (37)	3.6 (34)	4.0 (3)	3.3 (86)
20.1 - 21.0		3.0 (1)	4.0 (7)	4.0 (11)	3.9 (23)	4.0 (3)	3.9 (45)
21.1 +			4.0 (3)	4.1 (8)	5.0 (26)		4.7 (37)
Average for feed cons.	0.2 (14)	1.4 (19)	2.7 (111)	3.8 (203)	4.0 (125)	4.3 (14)	

Body wt. (lbs)	80	81-100	101-120	121-140	141-160	161 +	Av. for body wt.
Beltsville Small White:							
7.1 - 8.0	0.0 (1)	0.0 (3)	1.5 (10)	2.9 (29)	1.0 (1)		2.5 (44)
8.1 - 9.0	1.0 (5)	2.3 (13)	2.8 (35)	3.5 (69)	3.7 (26)		3.2 (148)
9.1 - 10.0	5.2 (2)	3.1 (13)	2.7 (34)	3.2 (44)	3.5 (27)	3.5 (6)	3.2 (126)
10.1 - 11.0	3.0 (3)	3.0 (4)	2.3 (11)	2.9 (11)	4.4 (5)	5.0 (1)	3.0 (35)
Average for feed cons.	2.2 (11)	2.5 (33)	2.6 (90)	3.3 (153)	3.6 (59)	3.7 (7)	

1/ Average daily feed consumption per bird based on a 7-day weigh back period.
2/ Average weekly egg production per bird at a particular level of feed intake and body weight.
3/ Number of observations on egg production.

Table 15 - Experiment 2. Average egg production of turkey hens at different levels of feed intake and body weight

Broad Breasted Bronze:	Feed consumed (gms)												Av. for
Body wt. (lbs)	150 [1]		151-200		201-250		251-300		301-350		351 +		body wt.
14.0 - 16.0	0.8[2]	(7)[3]	3.4	(5)	1.7	(14)	4.0	(4)	3.0	(1)	0.0	(4)	1.9 (35)
16.1 - 17.0	0.0	(6)	1.5	(18)	2.8	(57)	3.0	(51)	4.0	(25)	3.7	(14)	2.9 (171)
17.1 - 18.0	0.3	(6)	3.5	(13)	2.7	(45)	3.2	(53)	3.5	(17)	5.0	(4)	3.0 (138)
18.1 - 19.0	0.0	(4)	3.0	(9)	2.6	(52)	2.1	(50)	2.4	(27)	4.0	(12)	2.5 (154)
19.1 - 20.0	0.0	(1)	3.3	(8)	3.0	(92)	3.1	(82)	3.4	(49)	4.5	(20)	3.2 (252)
20.1 - 21.0	3.0	(1)	0.0	(1)	2.0	(6)	1.3	(15)	2.5	(9)	4.5	(6)	2.2 (38)
21.1 +					1.3	(3)	1.6	(14)	2.9	(13)	1.6	(3)	1.9 (33)
Average for feed cons.	0.4	(25)	2.6	(54)	2.7	(269)	2.9	(269)	3.2	(141)	3.8	(63)	
Beltsville Small White:													Av. for
Body wt. (lbs)	100 -		101-120		121-140		141-160		161-180		181 +		body wt.
7.1 - 8.0	0.5	(6)	2.8	(7)	1.0	(11)	0.8	(5)	0.0	(1)			1.3 (30)
8.1 - 9.0	1.2	(28)	2.6	(41)	1.7	(82)	2.8	(57)	4.2	(9)	3.8	(6)	2.3 (223)
9.1 - 10.0	3.1	(25)	2.2	(36)	2.7	(77)	2.3	(83)	2.5	(49)	2.6	(34)	2.5 (304)
10.1 - 11.0	1.1	(9)	1.6	(10)	2.4	(32)	2.4	(68)	3.0	(42)	2.5	(27)	2.5 (188)
11.1 - 12.0			3.0	(2)	2.3	(8)	0.1	(7)	1.3	(11)	1.3	(7)	1.4 (35)
Average for feed cons.	1.8	(68)	2.2	(96)	2.1	(210)	2.4	(220)	2.7	(112)	2.6	(74)	

1/ Average daily feed consumption per bird based on a 7-day weigh back period.
2/ Average weekly egg production per bird at a particular level of feed intake and body weight.
3/ Number of observations on egg production.

feed consumption are positively correlated and body weight and feed consumption are positively correlated in both varieties (Table 16).

F. Relationship of egg weight, egg number, body weight and age at first egg (Experiment 2)

The data presented in Figure 7 show that egg weight in both varieties of turkeys increased as the reproductive period progressed. The increase was approximately 21 grams in the BSW (53-74 grams) and approximately 24 grams in the BBB (67-91 grams). The average egg weight was 69 and 84 grams for the BSW and BBB, respectively.

Partial correlation values for egg weight, body weight and egg production are given in Table 17. These values suggest that egg number and egg weight are not correlated; however, average egg weight appears to be positively correlated with body weight at 31 and 58 weeks of age as well as the body weight nearest the last oviposition. There was also a positive correlation between the average weight of the first 10 eggs laid by each hen and age at first egg; thus, the eggs were larger in turkey hens starting to lay at 36 weeks rather than at 32 weeks of age.

A highly significant ($P < 0.01$) positive correlation was found between the average weight of the first 10 eggs and the average weight of the total eggs laid. Prediction values for the average egg weight for each hen from the equation $\hat{y} = a + bx$ were:

	BBB	BSW
a	13.00	20.70
b	.90	.74

Table 16. Partial correlation values for body weight, daily feed consumption and egg production of turkey hens

	No. of birds	Egg prod. vs. 1/ body wt.	Egg prod. vs. 2/ feed cons.	Body wt. vs. feed cons.
Experiment 1				
A. Beltsville Small White	30	- 0.19	+ 0.27	+ 0.36*
B. Broad Breasted Bronze	42	- 0.28	+ 0.33*	+ 0.65*
Experiment 2				
A. Beltsville Small White	35	- 0.47*	+ 0.49*	+ 0.47*
B. Broad Breasted Bronze	35	- 0.14	+ 0.18	+ 0.35*

1/ Body weight nearest last oviposition.

2/ Daily feed consumption data were calculated from the time period 14 days prior to first oviposition through week of last oviposition or termination of experiment.

* Significantly different $P < 0.05$.

Fig. 7 - Experiment 2: Egg weight changes by week in turkey hens.

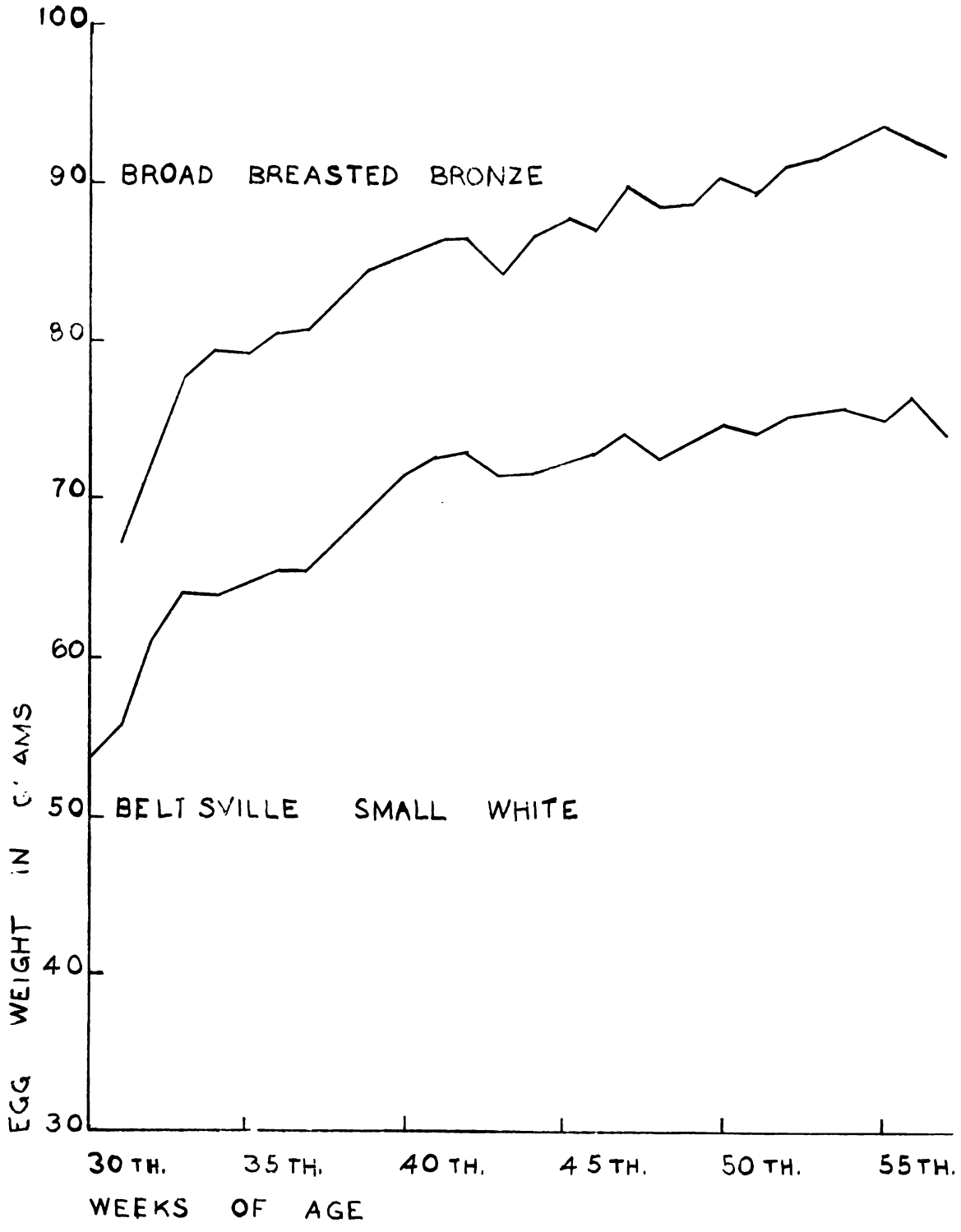


Table 17. Experiment 2. "r" values for egg weight, body weight and egg production of turkey hens

		Broad Breasted Bronze	Beltsville Small White
Egg weight I [1/]	vs number of eggs	+ 0.04	+ 0.05
Egg weight II [2/]	vs number of eggs	- 0.16	- 0.07
Egg weight I	vs body weight A [3/]	+ 0.48**	+ 0.33*
Egg weight II	vs body weight A	+ 0.70**	+ 0.34*
Egg weight I	vs body weight B [4/]	+ 0.05	+ 0.49**
Egg weight II	vs body weight B	+ 0.13	+ 0.39*
Egg weight II	vs age at first egg	+ 0.48**	+ 0.84**
Egg weight I	vs egg weight II	+ 0.88**	+ 0.91**
Egg weight I	vs body weight C [5/]	+ 0.33*	+ 0.30

* Significant at $P < 0.05$ level.

** Significant at $P < 0.01$ level.

1/ The average of all eggs laid.

2/ The average of the first 10 eggs.

3/ Body weight nearest last oviposition.

4/ Body weight at 31 weeks of age.

5/ Body weight at 58 weeks of age.

Where $\hat{y}$ = average weight of all eggs laid

x = average weight of the first 10 eggs laid

b = regression coefficient - slope

a = $\hat{y}$ intercept

G. Egg weight, clutch length, pause length and egg production (Experiment 2)

In general, egg production increased with an increase in the number of clutches in either variety; and in general, the clutch length was longer in the high producers (Figures 8 and 9). The 1-egg clutches were the most numerous (BSW 62.5 percent; BBB 42.0 percent); however, the BBB laid more of their eggs (644) in 2-egg clutches (Table 18). The percentage of clutches that had 4 or more eggs was 13.6 percent for the BBB and 2.3 percent for the BSW. The range of clutch length was 1 to 6 eggs in the BSW and 1 to 21 eggs in the BBB. Ninety-three and two-tenths (93.2) percent and 68.3 percent of the eggs laid by the BSW and BBB, respectively, were in clutches of three eggs or less.

In both varieties, the low producers (39 or less eggs) had longer pauses than did the high producers (86 or more eggs); however, the high producers had more (average 26.7, BBB; 34.8, BSW) 1-day pauses than did the low producers (Figures 10 and 11). The low producers were out of production an average of 90 (BBB) and 82.5 (BSW) days prior to the end of the experiment while the high producers had not ceased to lay.

Egg weight generally decreased as the clutch length increased (Table 18) and egg weight in both varieties increased

Fig. 8 - Experiment 2: Average number and length of clutches at different levels of egg production in Broad Breasted Bronze turkeys.

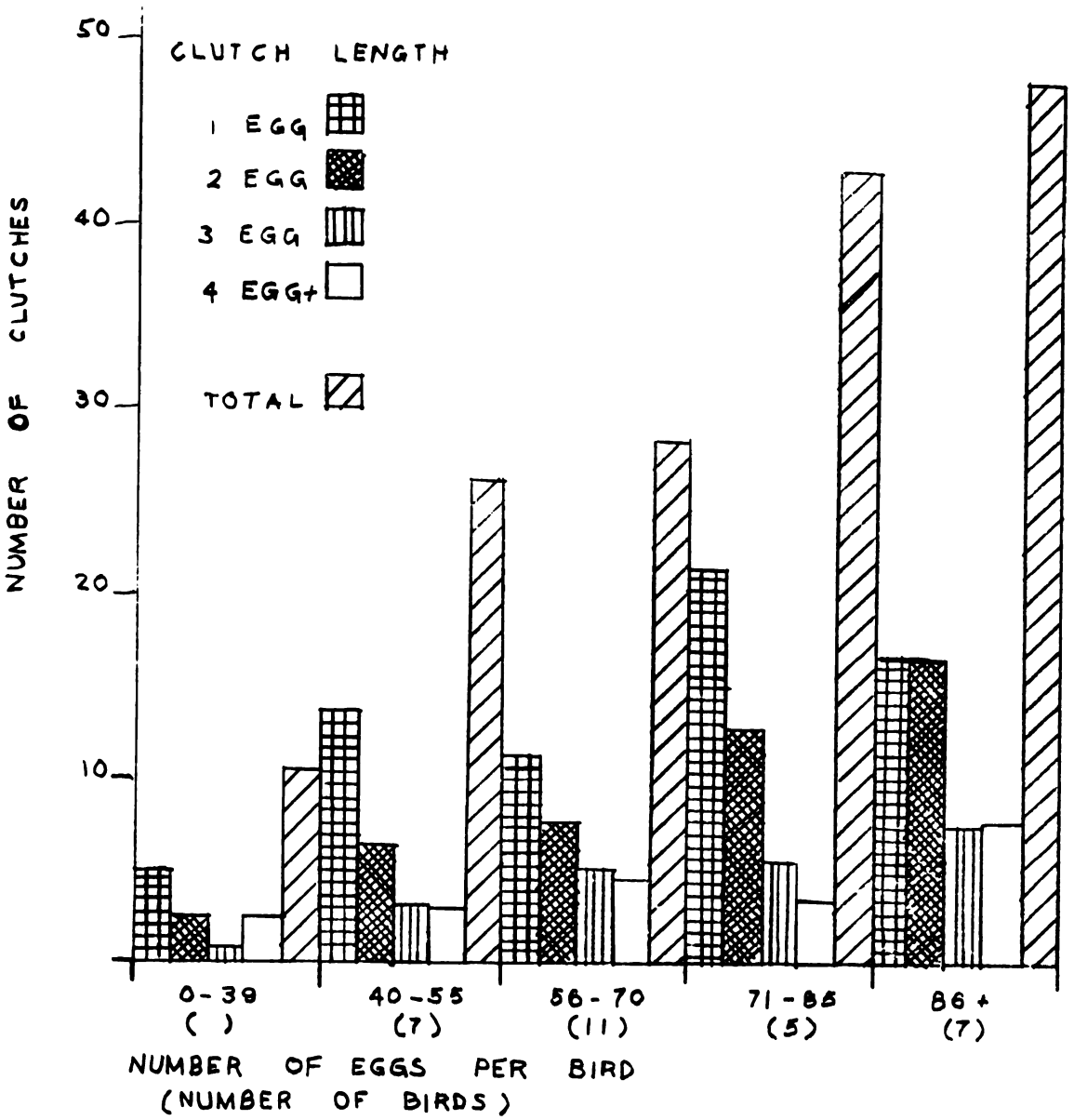


Fig. 9. - Experiment 2: Average number and length of clutches at different levels of egg production in Beltsville Small White turkeys.

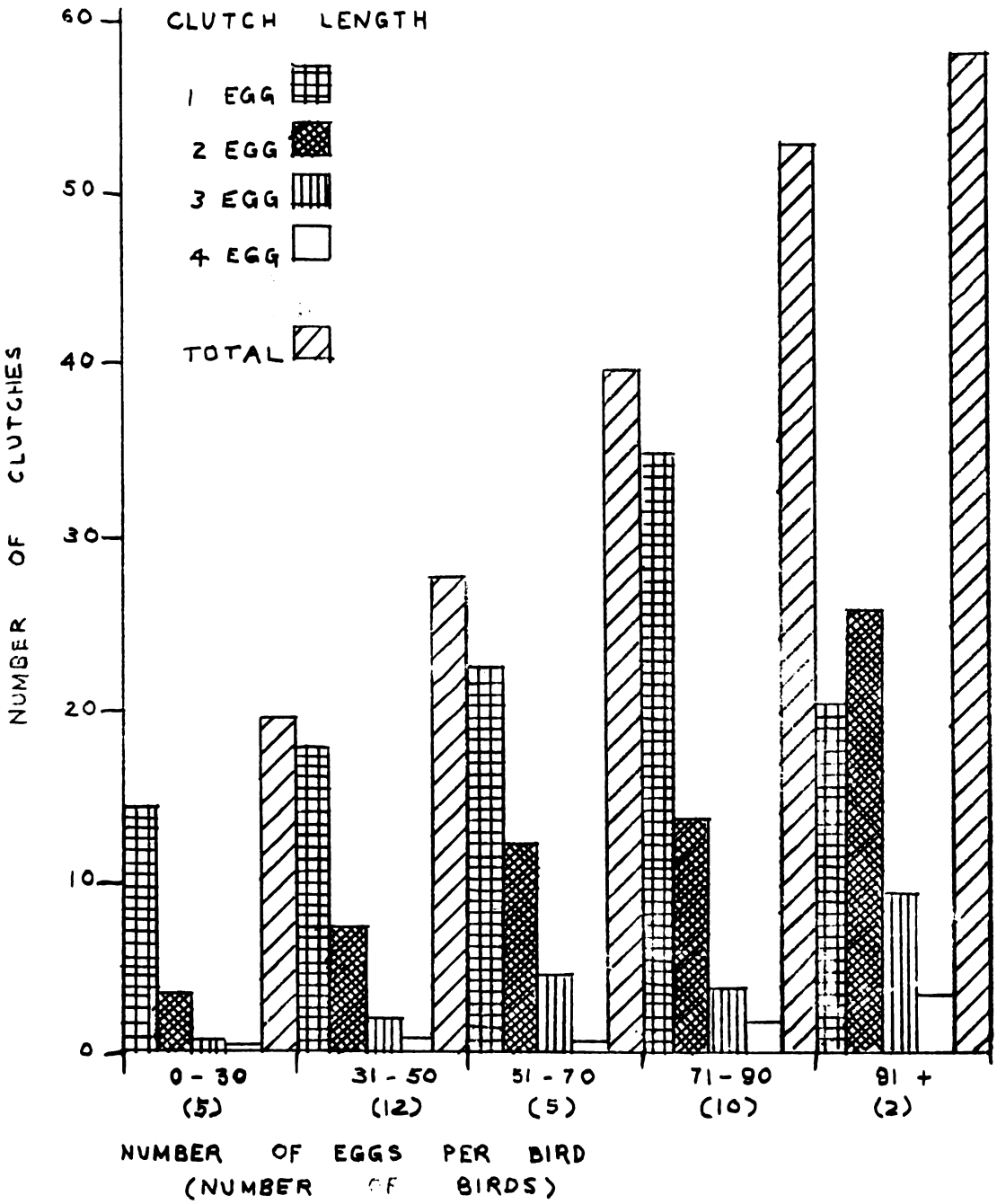


Table 18. Experiment 2. Average clutch length, average egg weight of the clutch and percentage of eggs produced in each clutch of the turkey hen

Variety	Clutch length (no.eggs)	Number of clutches	Percent 1/	Number of eggs	Percent 2/	Egg weight (gms)
Beltsville Small White	1	782	62.5	782	41.4	70.5
	2	344	27.5	688	36.4	70.0
	3	97	7.7	291	15.4	68.7
	4	19	1.5	76	4.0	68.0
	5	9	0.7	45	2.4	68.2
	6	1	0.1	6	0.4	67.0
Broad Breasted Bronze	1	459	42.0	459	19.7	85.4
	2	322	29.5	644	27.6	86.5
	3	163	14.9	489	21.0	85.4
	4	83	7.6	332	14.3	82.4
	5	36	3.3	180	7.7	81.8
	6	11	1.0	66	2.8	83.9
	7	7	0.6	49	2.1	83.3
	8	5	0.5	40	1.7	81.7
	9	1	0.1	9	0.4	84.3
	10	2	0.2	20	0.9	75.7
	11	2	0.2	22	0.9	78.4
	21	1	0.1	21	0.9	79.6

1/ Percent of total clutches that consisted of this number of eggs.

2/ Percent of total eggs produced that were laid in clutches of this length.

Fig. 10 - Experiment 2. Average number and length of pauses between clutches at different levels of egg production in Broad Breasted Bronze turkeys.

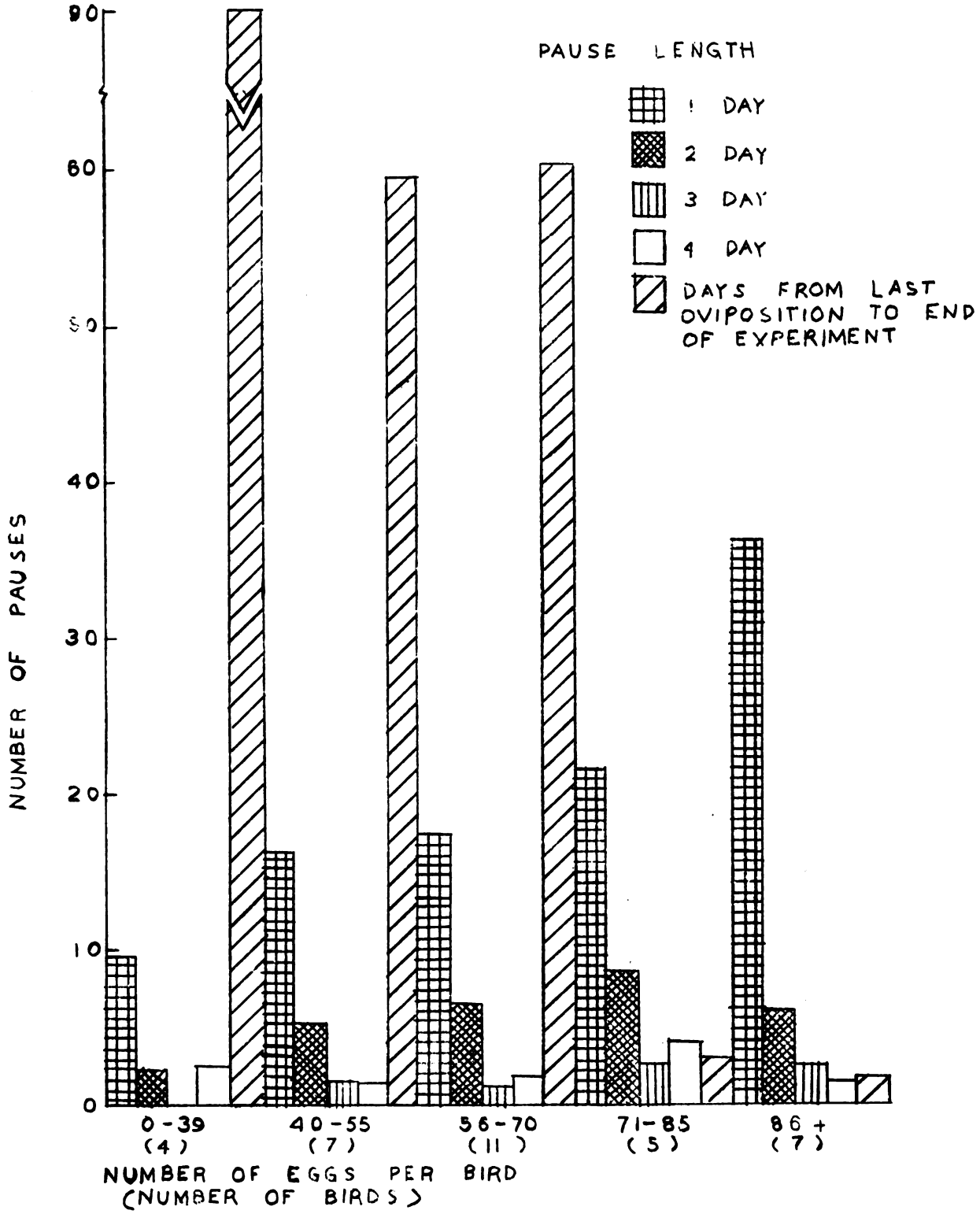
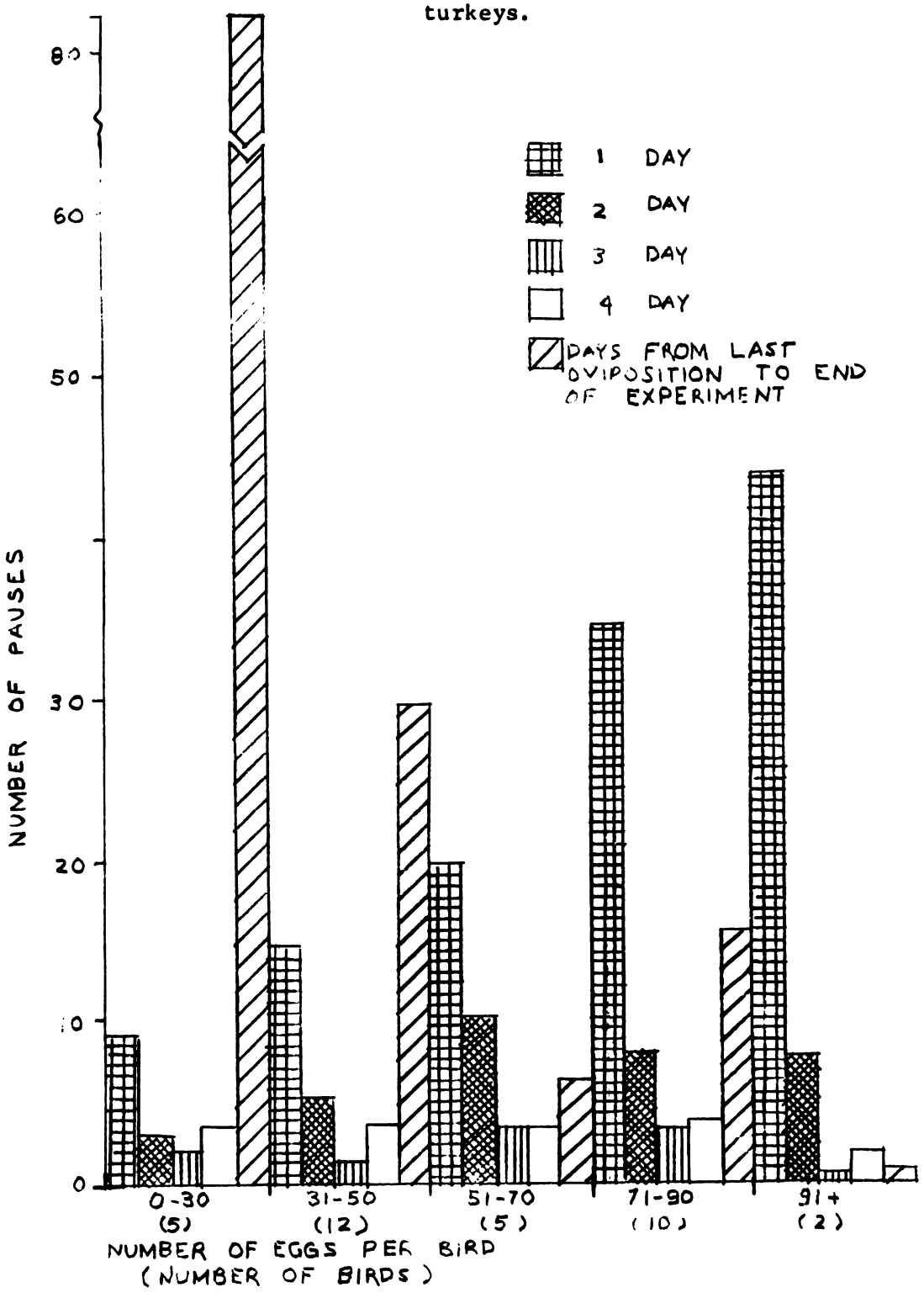


Fig. 11 - Experiment 2: Average number and length of pauses between clutches at different levels of egg production in Beltsville Small White turkeys.



throughout the experimental period (Figure 7).

H. Interval of time and delay between successive eggs (Experiment 2)

The first egg of the clutch was laid progressively earlier in the day as the clutch length increased; likewise, as the clutch length increased, the last egg of the clutch was laid progressively later in the day (Tables 19 and 20). The BBB laid 80 percent and the BSW laid 92 percent of their eggs in the afternoon. The average interval between successive eggs of a clutch was 26 hours and 46 minutes (BSW) and 25 hours and 48 minutes (BBB). The average interval was 27 hours and 12 minutes (BSW) and 26 hours and 30 minutes (BBB) between the first and second egg of all clutches having 2 or more eggs. The interval of time was generally shorter between successive eggs of the longer than between successive eggs of the shorter clutches; and in general, there was a longer interval between the next to last egg and the last egg of the clutch than between any other two successive eggs of the clutch.

The delay or lag in time of day laid between successively laid eggs was generally greater in short than in long clutches; and the interval between the first two eggs and between the last two eggs of the clutch was greater than that between intervening eggs (Figure 12). The average lag between the first and last egg within a clutch was 5.5 hours for the BSW hens laying their eggs in 2, 3 or 4-egg clutches and 6.3 hours for the BBB hens laying their eggs in 2, 3, 4, 5, 6, 7 or 8-egg clutches.

Table 19. Experiment 2. Average time of lay and average interval between successive eggs (Broad Breasted Bronze)

Egg number in clutch	Clutch length (eggs) 1	2	3	4	5	6	7
				Time of lay (hour and minutes) 1/			
1	1:40	12:20	11:40	11:20	11:20	11:30	9:30
2		4:30	1:30	1:10	12:40	1:30	1:20
3			5:20	2:30	2:10	1:45	1:00
4				5:30	2:40	1:45	4:00
5					5:30	3:20	1:30
6						6:10	4:15
7							7:00
				Interval between eggs (hours and minutes)			
1-2		28:10	25:50	25:50	25:20	26:00	27:50
2-3			27:50	24:20	25:30	24:15	23:40
3-4				27:00	24:30	24:00	27:00
4-5					26:50	25:35	21:30
5-6						26:50	26:45
6-7							26:45

1/ All times reported are between 8:00 a.m. and 7:00 p.m.

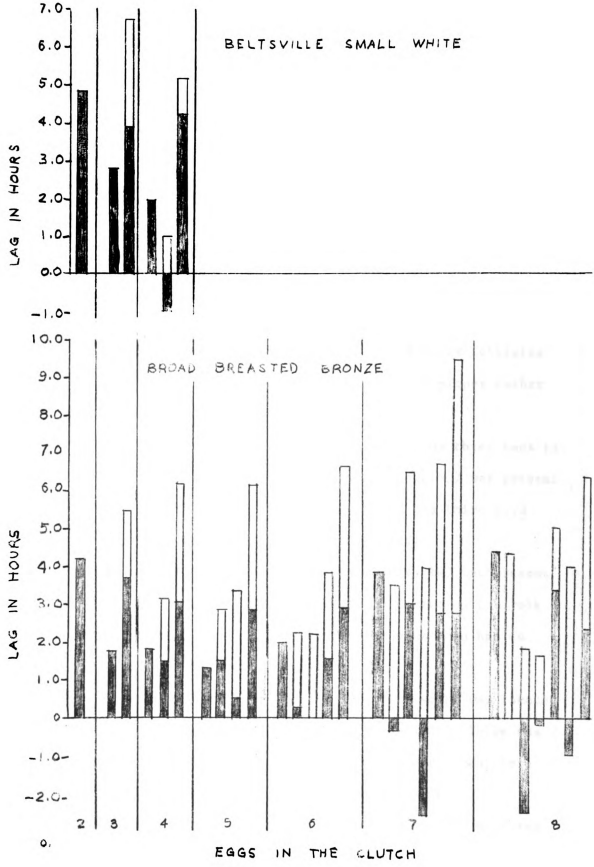
Table 20. Experiment 2. Average time of lay and average interval between successive eggs (Beltsville Small White)

Clutch length (eggs)	1	2	3	4
Egg number in clutch	Time of lay (hour and minutes) 1/			
1	3:55	1:00	11:30	1:10
2		5:50	2:20	3:10
3			6:10	2:10
4				6:20
	Interval between eggs (hours and minutes)			
1-2		28:50	26:50	26:00
2-3			27:50	23:00
3-4				28:10

1/ All times reported are between 8:00 a.m. and 7:00 p.m.

Fig. 12 - Experiment 2: The delay or lag in time of day laid between successive eggs in a clutch.

A 2-egg clutch is represented by one bar, a 3-egg clutch by two bars, etc. For the 3-egg clutch, the lag between the first and second egg from the BSW was 2.83 and between the second and third egg, 3.83 hours (second black bar). The accumulative lag (white bar) between the first and third egg was 6.67 hours.


BELTSVILLE SMALL WHITE
BROAD BREASTED BRONZE
LAG IN HOURS
LAG IN HOURS
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
-1.0
-2.0
0
2
3
4
5
6
7
8
EGGS IN THE CLUTCH

I. Ovulation time, egg formation time and oviduct length (Experiment 4)

The data presented in Table 21 show that the turkey hen ovulates 15-30 minutes after oviposition. The preceding and following information on egg formation, egg passage and ovulation times are based on the intercept of the second egg in the clutch. The following observations were made:

a. 15 minutes after oviposition - Ovulation, in one instance, had occurred; however, the ovum (yolk) had not yet entered the infundibulum. The other two hens had not ovulated, but when handled, one follicle in the ovary of each hen ruptured along the stigma. All of the other follicles so handled were torn away from the ovary proper rather than ruptured.

b. 30 minutes after oviposition - Two of the three hens in this group had ovulated and the ovum (yolk) was present in the infundibulum. One follicle of the third bird ruptured along the stigma when handled.

c. 1 hour after oviposition - The ovum (yolk) was present in the magnum and had thick albumen enclosing the yolk in two of the hens. The egg in the other hen had no albumen about the ovum (yolk).

d. 2 hours after oviposition - The ovum (yolk) was located more caudally in the magnum than at 1 hour. There was also more thick albumen enclosing the yolk than there had been in the birds sacrificed at 1 hour.

e. 3 hours after oviposition - The ovum (yolk), enclosed by thick albumen, was in the lower one-third of the magnum

Table 21. Experiment 4. Egg formation time in the Beltsville Small White turkey

Bird number	Time sacrificed [1]	Position in oviduct [2] cm	Position in oviduct [2] Place	Number of eggs laid [3]
77	15 min.	--	--	8
91	15 "	--	--	12
95	15 "	--	--	5
76	30 min.	--	--	5
85	30 "	3.0	Infundibulum	7
99	30 "	5.0	"	3
101	1 hour	20.0	Magnum	12
103	1 "	12.5	"	13
104	1 "	25.0	"	15
83	2 hours	22.0	Magnum	7
94	2 "	30.0	"	5
102	2 "	29.5	"	9
98	3 hours	57.0	Isthmus	18
96	3 "	42.0	Magnum	8
107	3 "	47.0	"	5
87	5 hours	80.0	Uterus	5
93	5 "	63.0	Isthmus	7
97	5 "	62.5	"	9
82	8 hours	71.0	Uterus	5
105	8 "	68.5	"	7
108	8 "	65.0	"	4
78	12 hours	62.5	Uterus	5
80	12 "	65.0	"	6
100	12 "	63.0	"	6
79	24 hours	60.0	Uterus	6
88	24 "	66.5	"	7
92	24 "	59.5	"	6
75	26 hours	61.0	Uterus	8
89	26 "	58.0	"	7
86	26 "	61.5	"	4

1/ Time after oviposition of first egg in the clutch.
2/ Centimeters from opening of the infundibulum to the egg.
3/ Number of eggs laid prior to sacrificing.

in two of the hens. The other hen had the ovum (yolk) present in the isthmus with the inner shell membrane present.

f. 5 hours after oviposition - Observations on three hens showed that in two cases the egg was in the isthmus, while in the other case, the egg was in the uterus but had no outer thin albumen present. The shell membranes were present on all three eggs.

g. 8 hours after oviposition - The egg in each hen was present in the uterus. Each of the eggs was plump; however, shell deposition was not apparent.

h. 12 hours after oviposition - Shell was being deposited on the egg's shell membranes in the uterus. The shell was not solid on one egg; however, the other two eggs did have solid shell.

i. 24 hours after oviposition - In all three hens the egg was in the uterus and had a solid, white shell. There was no visible pigment on the shell at this time.

j. 26 hours after oviposition - The egg was present in the uterus and in two of the three cases there was pigment deposited on the shell; however, this pigment was easily removed by rubbing. Visible chalaza were present in two of the three eggs.

Therefore, it would appear that during the formation of an egg, the time in the infundibulum is 15-30 minutes; the time in the magnum is 2½-3 hours; the time in the isthmus is 1-1½ hours; the time in the uterus is 22-24 hours, and in the

vagina the time is probably nominal.

The average lengths of the parts of the functional oviduct were 11.7 cm for the infundibulum, 41.3 cm for the magnum, 12.0 cm for the isthmus, 6.2 cm for the uterus and 4.8 cm for the vagina (Table 22). The average total length of the functional BSW turkey's oviduct was 76.0 cm.

Table 22. Experiment 4. Average lengths of the various parts of the oviduct in the Beltsville Small White turkey

Bird number	Length of oviduct (cm)					
	Infundibulum	Magnum	Isthmus	Uterus	Vagina	Total
77	12.5	40.5	13.0	7.0	5.0	78.0
91	12.5	36.0	14.0	6.0	5.0	73.5
95	11.0	41.0	11.0	7.0	4.5	74.5
76	12.0	42.0	13.0	5.5	4.0	76.5
85	10.5	33.0	11.0	5.5	3.0	63.0
99	13.0	44.0	16.0	8.0	5.0	86.0
101	18.0	41.5	12.5	5.5	5.0	82.5
103	9.5	39.5	13.5	5.0	5.0	72.5
104	12.5	46.0	13.0	6.5	5.0	83.0
83	11.0	41.0	13.5	9.5	5.0	80.0
94	12.0	43.0	12.0	8.0	5.0	80.0
102	12.5	40.5	11.0	6.5	5.0	75.5
98	14.0	39.0	10.5	5.0	5.0	73.5
96	12.0	37.0	9.5	6.0	5.0	69.5
107	16.0	41.5	9.5	5.5	4.5	77.0
87	12.5	56.0	11.5	7.0	5.5	92.5
93	13.0	37.0	19.0	6.0	6.0	81.0
97	9.5	43.0	11.0	6.0	5.0	74.5
82	11.5	45.5	14.0	6.0	5.0	82.0
105	12.0	45.0	11.5	6.5	4.5	79.5
108	11.0	42.0	12.0	7.0	5.0	77.0
78	11.0	40.0	11.5	5.5	5.0	73.5
80	11.0	41.0	13.0	6.5	4.5	76.0
100	11.5	42.0	9.5	5.0	4.5	72.5
79	11.0	39.0	10.0	5.5	4.0	69.5
88	9.0	43.5	14.0	6.0	5.0	77.5
92	11.0	40.0	8.5	7.0	5.0	71.5
75	10.0	39.5	11.5	5.5	4.0	69.5
89	9.0	41.0	8.0	5.0	4.5	67.5
86	10.5	38.5	12.5	5.5	4.5	71.5
Average	11.7	41.3	12.0	6.2	4.8	76.0
Std. error of mean	± 0.3	± 0.7	± 0.4	± 0.2	± 0.1	± 1.1

DISCUSSION

The reproductive performance of BBB and BSW turkey hens can be altered by employing various light regimes throughout the growing period. The results obtained indicate that either restricting or decreasing the daylength during the growing period will eliminate the apparent refractiveness of the hypothalmic-hypophyseal system to light during the late summer and early fall months. Similar conclusions were obtained by Leighton and Shoffner (1961) and McCartney et al. (1961) with a restricted light regime and by Clayton and Robertson (1960) with a decreasing light regime. Turkey hens receiving experimental photoperiod equal to that of natural daylength were refractive to a daylength increase at 28 weeks of age. The evidence for this refractiveness is based on the cessation of egg production by the BSW turkey hens and the average length of time required for the BBB females to produce their first egg following the daylength increase at 28 weeks of age. Length of day, increasing or decreasing daylength and time when the decreasing or increasing daylength occurred was very important in controlling or stimulating egg production in turkey hens.

Thus, out-of-season (late summer and early fall) egg production is possible in turkeys if the proper light regime (restricted or decreasing light program) is provided during the growing period. The disadvantage of the restricted light program is that it requires a completely darkened building; otherwise light reaching the birds during the latter part of the growing period will probably cause stimulation of the reproductive system. Therefore, the birds will probably not respond to a subsequent

light increase. A restricted light program also increases the ventilation hazards during hot weather or electrical power failure. The advantage of the decreasing light program is that birds are always receiving more light daily than that occurring naturally; therefore, no special environmental controls are needed.

Increasing the photoperiod 15 minutes weekly during the reproductive period did not significantly increase the reproductive performance of the turkey hens used in this study. However, increasing the photoperiod to 15 or 16 hours instead of 14 hours daily at 28 weeks of age generally decreased the number of days to the first egg.

The data obtained in this study indicate that, in general, within a given strain and/or variety of turkey hens, those hens producing the greatest number of eggs will have the highest daily feed intake. It also appears that those hens deviating most drastically from the average weight for the strain and/or variety will generally be the poorest egg producers. However, the data relating weekly egg production, body weight and feed consumption show that the largest hens were capable of high egg production for short periods of time; but sustained reproductive performance was generally lacking in the heavier hens. Daily feed intake of the turkey hens varied with intensity of egg production, body weight and genetic potential (BBB vs BSW). The hormonal balance may also have been a factor influencing the food intake. This aspect is suggested from the observations of a decreased food intake when egg production began and a decreased food intake following the onset of broodiness. The drop in daily feed consumption concurrent

with the onset of egg production is unexplainable from the data obtained, although Meites (1949) injected natural and synthetic estrogen into rats and concluded that diethylstilbestrol (an estrogenic compound) curtails growth in rats principally by decreasing appetite while natural estrogens (estradiol) inhibit growth without any corresponding decrease in appetite.

The decrease in body weight following the onset of egg production is in agreement with the data reported by Asmundson et al.(1946), in the Annual Report of the Indiana Agricultural Experiment Station (1934) and by Harper (1950). Thus, it appears that the turkey hen may draw upon her body stores in order to maintain egg production. The utilization of body stores is quite apparent when one calculates calorie intake in the feed, maintenance calories required (Brody, 1945) and caloric output in the egg (Romanoff and Romanoff, 1949) for the BSW turkey hen. Caloric input and output data during the first four weeks of egg production in the BSW turkey hens which received treatment 4 shows that they did not eat enough feed to meet the caloric requirements for maintenance and egg production (Appendix, Table 3). Therefore, it appears that these turkey hens utilized their body stores in order to maintain egg production. An evaluation of the data obtained on nitrogen balance of BSW turkeys at onset of oviposition indicates that the body weight loss may partially be due to catabolism of the muscle protein because at this time the turkeys were in a negative nitrogen balance. However, the utilization of body fat deposits or a shift in the water content of body tissues may also explain the body weight decrease that occurred when egg production began.

In general, the turkeys receiving the restricted light program gained less than the birds receiving any of the other light programs from 4 to 19 or 21 weeks of age. The decreased growth rate may have resulted from a lowered feed intake by the birds on the restricted light program. Thus, the lowered feed intake data indicates that the decreased daylength may have prevented optimum feed consumption, thereby preventing maximum growth. However, an evaluation of the economic factors involved would be necessary before one lighting program could be judged superior in growing turkeys as market birds. The most important factors would probably be feed cost differences, body weight differences, feed conversion, carcass quality and feathering. That feed conversion and growth rate are influenced by daylength has been shown by McCartney (1956). His research indicated that turkeys reaching market age during the winter months when the days are short should be artificially lighted to provide at least 13 hours of light per day to attain maximum growth at 20 weeks of age.

The egg formation and ovulation times in the BSW turkey resemble those obtained by Warren and Scott (1935) for the chicken. However, it would appear that the longer egg formation time in the turkey probably results from additional time spent in the uterus. The average observed time the egg was in the various parts of the BSW turkey's oviduct was comparable to that reported by Asmundson (1939) for the BBB and a large white variety. However, the average length of the functional BSW turkey oviduct was shorter than the oviducts he measured. This difference may have resulted from the length of the reproductive period before the oviducts

were measured. The BSW turkey females used in this study had produced only a maximum of 18 eggs; whereas, the turkey females used by Asmundson (1939) had gone through a six-month reproductive period.

The data obtained on egg shell pigmentation agrees with that reported by Warren and Conrad (1942). Thus it appears that pigment deposition occurs only during the last 2 to 3 hours before oviposition in the turkey female.

Although two eggs were not observed in the oviducts of any of the BSW turkeys sacrificed, the possibility still exists that a second yolk may be ovulated and start down the oviduct while the first egg is still in the uterus. The reason for suggesting this possibility is that several turkey hens, both BSW and BBB, in Experiment 1, were observed to lay two eggs in one 24 hour period. Secondly, it was observed that several of the eggs in the multiple egg clutches (4 or more eggs) had a time interval of less than 23 hours (Tables 19 and 20). The egg formation time may be shorter in these hens; however, since Warren and Scott (1935) observed two eggs in the chicken oviduct at one time and since Arrington *et al.* (1962) observed two eggs in the quail oviduct at one time, it is more likely that the extreme shortened intervals of 16 to 20 hours between eggs is primarily due to two eggs passing through the oviduct at one time.

The dependence of egg production on intensity and persistency was emphasized by the results obtained in this study. High producing turkey hens (86 eggs or more) had fewer pauses, shorter pauses, longer clutches and more clutches than did the low

producers, (39 eggs or less). In general, there was a shorter interval between the eggs produced in multiple egg-clutches than in the 2-egg clutches.

These data do not explain the reason for turkeys laying a larger percentage of their eggs in the afternoon (80 percent, BBB; 92 percent, BSW). Although the percent of eggs laid in the afternoon was higher in this study than that reported by other researchers (Stockton and Asmundson, 1950; Kosin and Abplanalp, 1951; Payne and Ortman, 1956), the results are not in disagreement with their conclusion that turkeys lay more of their eggs in the afternoon. However, it appears possible to obtain turkeys that start their clutches in the early morning because it was observed that the first egg of multiple egg clutches was laid in the forenoon while the first egg of the 1 or 2-egg clutches was laid in the afternoon. Since the turkey ovulated at about the same time following oviposition as the chicken, this doesn't explain the differences in the time of lay (forenoon vs afternoon). It may be postulated that the turkey's afternoon oviposition time could partially result from egg formation requiring 2-4 more hours in the turkey (26-28 hours) than in the chicken (24-26 hours; Warren and Scott, 1935). However, it is more likely that the time elapsing between the release of luteinizing hormone (LH) and ovulation are different for the chicken and turkey. For example, the egg laying cycle of the chicken can be predicted from the following assumptions:

1. Average egg formation time of 25.5 hours (Warren and Scott, 1935).

2. Interval between LH release and ovulation averages 7 hours (Rothchild, 1946; Rothchild and Fraps, 1949).
3. Ovulation occurs an average of 30.7 minutes after oviposition (Warren and Scott, 1935).
4. No LH release will occur during the lighted hours, probably because of activity (McNally, 1947; Fraps et al., 1947).
5. Release of LH for first egg of the clutch occurs approximately 2-3 hours after the lights are turned off (Fraps, 1959).
6. The lag in hours between the first and third egg of a 3-egg clutch is 2.6 hours; and the lag in hours between the second and third egg of a clutch is 3.4 hours (Sturkie, 1954).
7. The hens receive 14 hours of light daily (5:00 a.m. - 7:00 p.m.). Then each 3-egg cycle (clutch + day of skip) would show the following times of ovulation, LH release and oviposition.

	Day #1	Day #2	Day #3	Day #4	Day #5	Day #6	Day #7
LH release	10:00 pm	12:36 am	4:00 am	None	10:00 pm	12:36 am	4:00 am
Ovulation	None	5:00 am	7:36 am	11:00 am	None	5:00 am	7:36 am
Oviposition	12:30 pm	None	6:30 am	9:06 am	12:30 pm	None	6:30 am

However, in the BSW turkey hen, it appears that ovulation occurs 30 minutes after oviposition, egg formation time averages 26 hours and 40 minutes and the lag in hours between eggs 1 and 3 is 6 hours and 40 minutes, between eggs 1 and 2 is 2 hours and 50 minutes and between eggs 2 and 3 is 3 hours and 50 minutes in the

3-egg clutches. Then, it seems possible that the interval of time between LH release and ovulation approaches 12 hours. The 3-egg cycle for turkeys receiving 16 hours of light (4:00 a.m.-8:00 p.m.) would show the following times for ovulation, LH release and oviposition:

	Day #1	Day #2	Day #3	Day #4	Day #5	Day #6	Day #7
LH release	9:00 pm	11:50 pm	3:40 am	None	9:00 pm	11:50 pm	3:40 am
Ovulation	None	9:00 am	11:50 am	3:40 pm	None	9:00 am	11:50 am
Oviposition	6:20 pm	None	11:40 am	2:30 pm	6:20 pm	None	11:40 am

Thus, the projected oviposition times of 11:40 a.m., 2:30 p.m., and 6:20 p.m. compared favorably with the average actual times observed (Table 20) of 11:30 a.m., 2:20 p.m. and 6:10 p.m. for the BSW turkey hens laying in 3-egg clutches. Therefore, the afternoon laying habit of the turkey appears to result from a longer time interval between LH release and ovulation than that observed in the chicken.

SUMMARY

Individual egg production, body weight and feed consumption data were obtained on two varieties of turkey hens, Beltsville Small White (BSW) and Broad Breasted Bronze (BBB), following exposure to various light regimes during the growing and subsequent reproductive period. Data were also collected on oviposition time, ovulation time, egg formation time, oviduct length, clutch length and egg weight.

Feed intake, regardless of light regime or variety, increased sharply 10-14 days prior to onset of egg production; however, during the two weeks following this point, feed consumption decreased 10-30 percent. Feed consumption averaged 252 grams (.55 lbs.) daily per hen for the BBB and 137 grams (.30 lbs.) daily per hen for the BSW turkey hens during the reproductive period. Partial correlation values calculated for egg production, body weight and feed consumption indicate that egg production and body weight are negatively correlated; egg production and feed consumption are positively correlated and body weight and feed consumption are positively correlated in both varieties.

Ovulation in the BSW turkeys used in this study occurred 15-30 minutes after oviposition. Deposition of shell on the egg was started 11-12 hours after ovulation and the shell pigment was deposited during the last 2-3 hours the egg was in the uterus. From the data obtained, it is suggested that the egg was in the infundibulum 15-30 minutes, in the magnum 2½-3 hours, in the isthmus 1-1½ hours and in the uterus 22-24 hours.

The average interval between successive eggs of a clutch was 26 hours and 46 minutes (BSW) and 25 hours and 48 minutes (BBB). This time interval was generally shorter between successive eggs of four and more egg clutches than between the two eggs of two-egg clutches.

Egg weight increased 21 grams in the BSW and 24 grams in the BBB turkeys during the experimental period (28 weeks of lay). The average egg weight was 69 and 84 grams for the BSW and the BBB, respectively.

The body weight of both varieties, regardless of lighting regime, increased until onset of egg production. Within 4 to 5 weeks after egg production began, body weight decreased. In the first year of the study the birds did not regain the weight lost following the start of reproduction; however, in the second year this was not the case. In both varieties, the hens which received the restricted photoperiod during the growing period were lighter than the other groups at the time they were placed in cages (19 or 21 weeks of age) and, in general, were significantly lighter throughout the experiments.

From the data obtained, it appears that either restricting or decreasing the photoperiod during the growing period will enhance the turkey's out-of-season egg production. Females which had received a photoperiod equal to that of natural daylight during the growing period (March 21 to October 10) produced their first eggs 16 (BSW) and 20 (BBB) days later and produced significantly fewer eggs during the reproductive period than did turkey hens on either the restricted or decreasing photoperiod.

Thus, the data indicate that turkey hens can be stimulated to produce eggs during the late summer and early fall months by proper management of the photoperiod during the growing phase. However, the light treatments used in this study did not extend the length of the reproductive period beyond that which occurs under natural lighted conditions.

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APPENDIX

Table 1. . Experiment 1. Pen and outside temperatures recorded after the birds were placed in cages (20 weeks of age)

Age in weeks	Treatment 1/, 2/ 1-N		2 - R		3 - D		Outside 3/	
20-21	53.0	44-70	51.0	42-68	52.2	44-66		
21-22	47.0	42-54	46.8	42-52	46.6	44-50	37.5	18-53
22-23	44.5	38-48	43.5	36-46	42.5	34-48	17.1	3*-31
23-24	44.8	42-48	44.1	41-47	43.2	40-47	24.1	16-35
24-25	43.3	32-48	43.7	32-48	43.0	32-47	13.5	7*-42
25-26	46.0	44-48	45.5	44-48	45.3	42-48	24.0	5-38
26-27	46.5	46-50	47.2	46-50	45.8	43-48	26.4	5-43
27-28	47.4	44-54	46.0	44-54	46.0	42-48	32.1	15-54
28-29	45.3	44-48	45.7	43-49	44.6	40-48	12.4	8*-26
29-30	44.2	36-47	44.8	38-47	43.3	36-47	9.4	10*-22
30-31	45.4	42-46	45.2	42-46	43.5	40-46	12.2	10*-38
31-32	48.1	46-54	46.4	44-50	46.0	42-50	29.8	6-53
32-33	48.6	46-54	47.2	44-52	47.0	44-54	34.2	15-55
33-34	48.8	44-54	46.8	42-52	46.5	44-50	35.4	18-52
34-35	48.3	46-56	47.2	44-56	47.5	44-54	41.4	22-65
35-36	46.5	45-53	46.3	45-52	46.4	43-52	31.2	12-45
36-37	47.2	44-56	46.7	45-54	47.0	45-54	31.8	13-50
37-38	51.7	46-64	51.0	43-64	50.6	44-60	46.0	26-72
38-39	46.2	42-54	47.2	43-54	47.5	45-54	32.7	18-48
39-40	47.2	44-56	48.3	45-56	48.2	46-56	36.7	21-53
40-41	47.4	42-62	49.0	40-62	49.5	46-64	40.8	27-63
41-42	55.5	42-71	57.3	45-70	54.3	46-68	51.0	33-72
42-43	51.2	45-58	51.7	45-62	51.9	47-63	43.4	29-58

* Designates negative temperature .

1/ N = natural light, R = restricted light, D = decreasing light.

2/ Average pen temperature and the range during the week was based on an 8:00 a.m. and 4:00 p.m. reading.

3/ Average outside temperature and the range during the week was based on data obtained from the U. S. Weather Bureau, Capital City Airport, Lansing, Mich.

Table 2. . Experiment 2. Pen and outside temperatures recorded after the birds were placed in cages (19 weeks of age)

Age in weeks	Treatment 1/ 2/ 4 - D		5 - R		6 - N		Outside 3/	
19-20	72.2	66-80	71.9	66-80	71.1	66-81	68.1	51-84
20-21	73.5	63-84	73.6	58-84	72.2	58-84	70.1	43-87
21-22	70.3	60-81	70.5	60-84	68.6	63-81	66.7	46-86
22-23	70.3	59-84	71.2	59-84	69.2	58-84	67.7	44-87
23-24	76.7	70-84	76.6	68-84	74.4	68-82	75.2	62-88
24-25	75.5	66-84	75.8	66-84	72.8	66-82	74.7	57-87
25-26	65.6	53-80	65.2	52-80	63.0	50-80	62.4	43-85
26-27	68.7	64-80	68.3	54-80	66.0	53-76	66.5	41-84
27-28	57.6	48-73	57.8	46-74	54.7	44-71	51.1	30-78
28-29	59.7	48-74	60.4	46-72	59.0	44-74	56.4	30-77
29-30	59.3	46-76	59.3	46-76	57.6	44-74	53.8	30-79
30-31	56.0	48-70	56.1	46-62	54.3	44-68	52.4	38-73
31-32	53.3	46-61	54.2	45-62	51.2	43-60	49.2	35-61
32-33	52.7	46-67	52.3	50-68	51.4	43-66	46.4	27-73
33-34	49.8	46-60	49.2	43-62	47.9	44-60	41.2	23-65
34-35	48.0	47-54	47.0	44-56	46.0	42-54	36.0	20-63
35-36	46.8	45-54	46.3	44-54	45.3	43-52	35.7	18-55
36-37	47.9	44-58	48.1	44-61	46.3	43-58	37.0	21-58
37-38	44.0	41-46	44.9	43-47	44.0	43-45	24.1	10-40
38-39	42.1	30-47	44.5	36-47	42.8	36-45	27.2	5-35
39-40	44.9	43-46	45.0	43-47	43.1	42-44	22.7	0-32
40-41	42.2	34-45	44.7	38-47	42.1	36-45	20.1	2*-41
41-42	44.0	41-46	45.2	44-47	42.9	40-44	15.2	2*-39
42-43	43.8	40-47	40.7	34-46	38.4	32-44	16.0	6*-34
43-44	42.7	40-46	44.0	42-46	41.4	38-44	17.7	13*-37

* Designates negative temperature.

1/ N = natural light, R = restricted light, D = decreasing light.

2/ Average pen temperature and the range during the week was based on an 8:00 a.m. and 4:00 p.m. reading.

3/ Average outside temperature and the range during the week was based on data obtained from the U. S. Weather Bureau, Capital City Airport, Lansing, Mich.

Table 2. . Experiment 2. Pen and outside temperatures recorded after the birds were placed in cages (19 weeks of age) (Cont'd)

Age in weeks	Treatment 1/ 2/ 4 - D		5 - R		6 - N		Outside 3/	
44-45	44.2	42-46	45.0	42-47	43.0	39-44	17.1	4*-31
45-46	44.0	38-48	44.7	42-51	42.2	38-47	18.5	2*-50
46-47	42.9	39-46	43.9	39-46	41.6	36-44	21.0	3*-33
47-48	43.2	42-45	44.8	44-46	43.4	42-44	24.5	14-34
48-49	43.3	41-45	45.2	44-47	43.4	43-44	18.8	5*-38
49-50	44.1	40-46	45.0	43-47	42.3	40-44	20.5	9*-36
50-51	45.4	43-48	46.2	44-50	44.5	43-48	33.7	25-43
51-52	45.2	44-46	45.1	44-48	43.7	42-46	33.7	23-44
52-53	45.9	44-52	46.7	42-55	46.2	43-54	42.8	22-75
53-54	49.0	44-66	49.7	44-66	48.5	42-66	35.5	21-50
54-55	46.7	44-59	47.4	44-59	45.5	42-59	40.5	24-59
55-56	47.3	44-59	47.2	43-60	45.5	38-60	36.5	23-58
56-57	51.6	44-65	52.5	44-66	50.1	41-63	55.2	29-84
57-58	64.4	46-76	64.9	46-76	58.3	42-74	59.4	42-83

* Designates negative temperature.

1/ N = natural light, R = restricted light, D = decreasing light.

2/ Average pen temperature and the range during the week was based on an 8:00 a.m. and 4:00 p.m. reading.

3/ Average outside temperature and the range during the week was based on data obtained from the U. S. Weather Bureau, Capital City Airport, Lansing, Mich.

Table 3. Theoretical calculations of the caloric deficit during the first four weeks of egg production in Beltsville Small White turkey hens (Experiment 2, Treatment #4)

Bird No.	Body wt. (Kg.) 1/	No. of eggs 2/	Egg wt. (gms.)	Egg calories produced 3/	Maintenance calories 4/	Feed cons. (gms.)	Feed calories 5/	Calorie difference
Beltsville Small White								
6	4.09	18	1282	2166	6020	3269	6734	- 1452
18	4.22	18	1207	2039	6300	3787	7801	- 538
20	4.72	18	1233	2083	6860	3626	7469	- 1474
2	4.36	19	1262	2132	6440	3311	6820	- 1752
4	4.50	16	1088	1838	6580	2817	5803	- 2615
8	5.40	10	702	1186	7280	3626	7469	- 997
10	4.31	20	1378	2328	6384	2821	5811	- 2901
12	4.59	20	1259	2127	6720	3885	8003	- 844
14	4.95	6	439	741	7056	3150	6489	- 1308
16	4.31	20	1322	2234	6384	3318	6835	- 1783
22	4.31	13	865	1461	6384	2513	5176	- 2669
24	4.59	16	1109	1874	6720	4403	9070	+ 476
Av.	4.52	16	1095	1850	6594	3377	6956	- 1488

1/ Body weight at 36 weeks of age.
2/ Production over the first 28 days of egg production.
3/ Egg calories based on 1.69 calories per gram of egg (Romanoff and Romanoff, 1949).
4/ Maintenance calories based on figures of Brody (1945) for 28 days.
5/ Calories per gram of feed calculated as 2.06 calories.

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