



North Carolina Cooperative Extension Service

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FIRST CYCLE REPORT OF THE THIRTIETH

NORTH CAROLINA LAYER PERFORMANCE

AND MANAGEMENT TEST

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The North Carolina Layer Performance and Management Test is conducted under the auspices of the Cooperative Extension Service at North Carolina State University and the North Carolina Department of Agriculture. The flock is maintained at the Piedmont Research Station, Salisbury, North Carolina. Mr. Raymond Coltrain is Piedmont Research Station Superintendent; Mr. Ed Radford is Resident Manager of the flock; and Dr. K. E. Anderson is Project Leader. The purpose of this program is to assist poultrymen in evaluation of commercial layer stocks and management systems.

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30TH NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST

Protocol Procedures Used

Entries:

Twelve entries were accepted in accordance with the rules and regulations of the test. Eight white egg and four brown egg strains participated.

Dates of Importance:

The eggs were set on January 27, 1992 and hatched on February 19, 1992. The pullets were moved to laying facilities on June 22 to 25, 1992 (18 weeks of age). First cycle production records commenced on June 30, 1992 (19 weeks of age) until molt was induced on May 5, 1993. This report includes production data summarized 19 to 63 weeks and molt data 64 to 65 weeks.

Pullet Housing:

House 6 - is an environmental controlled brood-grow facility with 4 banks of triple-deck cages. Each side of each bank was assigned a row number, and each 3-cage section within each row and level/row was assigned a replicate number. For statistical analysis pairs of rows were designated as blocks. Thus, each block consisted of two rows containing 8 replicates on each level, plus one extra cage on each level of each row. The white and brown-egg strains were randomly assigned to the replicates in the house. Entrant strains were assigned to the replicates in a restricted randomized manner with the restrictions being that all strains were approximately equally represented in all rows and levels. Chicks were brooded in the center level of cages on paper within each of the replicate series (i.e. the 3 cage levels) within each row. Each center-cage-level replicate was filled with 90 white-egg (30 per 61 x 51 cm cage) and 90 brown-egg (30 per 61 x 51 cm cage) pullets on the day of hatch. At 42 days of age, 1/3 of the birds in each brooding replicate were moved to the top cages, and 1/3 were moved to the bottom cages for a final rearing allowance of 48 sq in for the white-egg and brown-egg pullets.

House 8 - is an open-sided brood-grow facility with six rows of 122 cm wide by 102 cm deep single deck cages with each cage assigned a replicate number. The white and brown-egg strains were randomly assigned to the replicates in each house. Entrant strains were assigned to the replicates in a restricted randomized manner with the restrictions being that all strains were approximately equally represented in all rows. Forty white-egg or brown-egg females were started and grown in each replicate. Refer to the 30th North Carolina Layer Performance and Management Test Growing Report (Vol. 30, No. 2) for details of pullet management, nutrition, and performance.

Pullets from all strain and pullet housing combinations were moved to both laying houses randomly over a three-day period. Photoperiod in both laying facilities was 16.5 hours light, 7.5 hours dark, with artificial illumination provided by compact fluorescent lamps.

Test Design:

The test was a factorial arrangement of treatments. Main effects were strain, layer housing, and density. The following are general descriptions of the main effects:

Strain

Samples of fertile eggs were provided from the breeders. All eggs were set and hatched concurrently. A total of eight white egg strains and four brown egg strains participated in the test.

Layer Housing

Two lay houses (4 and 5) were utilized. House 4 is a high rise, environmentally controlled facility with three banks of four-deck high cages. Each side of each bank was designated as a row, and each row was divided into nine eight-foot replicate blocks/level. The replicate blocks contain cages that are either 61 or 81 cm wide. All cages are 35.5 cm deep. House 5 is a standard height open-sided laying house with a flush manure handling system. It has two banks of triple deck cages and two banks with four levels of cages. Again, each side of a bank was designed as a row and each row was divided into nine eight-foot replicate blocks/level. The replicate blocks contain cages that are either 61 or 51 cm wide. All cages are 35.5 cm deep. Both houses contain feeder systems which allow feed consumption to be determined per replicate block. The white-egg and brown-egg strains were assigned to the replicates in a restricted randomized manner, with the restrictions being that all strains were approximately equally represented in all rows, levels and cage sizes.

Density

Two densities were used throughout the test. Hens were housed at either 361 cm² or 482 cm². Hen populations were held constant at placement to 6 hens per cage with 24 or 18 hens per replicate depending on cage lengths of 61 cm or 81 cm.

Layer Management and Nutrition:¹

Layer diets are identified as Diets D, E, F, G, H, I, M, N, O, P, and Q. Formulations are presented in the succeeding section. Feed was offered ad libitum in accordance with the following guidelines:

MINIMUM DAILY INTAKE OF NUTRIENTS PER BIRD AT VARIOUS STAGES OF PRODUCTION

Production Stage	> 87% and Pre-Peak	87-80%	80-70%	<70%
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White-Egg Layers

Protein (g/day)	19	18	17	16
Calcium (g/day)	3.8	3.8	4.0	4.0
Lysine (mg/day)	820	780	730	690
TSAA (mg/day)	700	670	630	590

Brown Egg Layers

Protein (g/day)	20	19	18	17
Calcium (g/day)	3.8	3.8	3.8	4.0
Lysine (mg/day)	830	820	780	730
TSAA (mg/day)	710	700	670	630

¹A problem was incurred with the feed during peak production, at 28 weeks of age. The commercial mill switched to new crop corn without notification. The corn had two problems associated with it: first, it was low in protein by 1%; second, it contained fusarium toxin. This was rectified in subsequent feed deliveries, however, production was depressed for a short period of time.

LAYING HOUSE FEEDING PROGRAM

Rate of Production	Consumption Per 100 Birds/Day (kg)	Diet Fed	
		White Egg Strains	Brown Egg Strains
Weeks 19-20	< 9.52	D	D
Pre-Peak and > 87%	< 9.52	F	E
	9.57-10.39	G	F
	10.43-11.29	I	H
	11.34-12.20	N	M
	12.25-13.11	P	O
	>13.15	Q	Q
80-87%	< 9.52	G	F
	9.57-10.39	H	G
	10.43-11.29	M	I
	11.34-12.20	O	N
	12.25-13.11	Q	P
	>13.15	Q	Q
70-80%	< 9.52	H	G
	9.57-10.39	I	H
	10.43-11.29	N	M
	11.34-12.20	P	O
	12.25-13.11	Q	Q
	>13.15	Q	Q
< 70%	< 9.52	I	H
	9.57-10.39	M	I
	10.43-11.29	O	N
	11.34-12.20	Q	O
	12.25-13.11	Q	Q
	>13.15	Q	Q
Post-Molt < 70%	< 9.52	G	F
	9.57-10.39	H	G
	10.43-11.29	M	I
	11.34-12.20	O	N
	12.25-13.11	Q	P
	>13.15	Q	Q

LAYING PERIOD DIETS

Diet Identification¹

Ingredient	Pounds per Ton					
	D	E	F	G	H	I
Corn	959.6	1029.2	1113.1	1184.6	1245.8	1312.0
Soybean Meal	737.3	679.7	624.8	574.7	530.6	485.4
Wheat Midds						.6
Limestone	200.1	194.2	184.7	179.5	174.1	167.3
Methionine	.8	.8	.3	.6	.7	.9
Dical Phos	28.4	28.2	26.8	24.3	24.0	22.5
Salt	6.2	5.6	5.5	5.4	5.4	5.3
Vit. premix	2.0	2.0	2.0	2.0	2.0	2.0
Min. premix	1.0	1.0	1.0	1.0	1.0	1.0
Poultry Fat	61.6	56.3	38.8	24.9	13.4	
Mold Inhibitor	2.0	2.0	2.0	2.0	2.0	2.0
Tracer	1.0	1.0	1.0	1.0	1.0	1.0
Total	2000.0	2000.0	2000.0	2000.0	2000.0	2000.0
Protein %	22.0	20.9	19.9	19.0	18.2	17.4
ME kcal/kg	2871.0	2900.0	2900.0	2900.0	2900.0	2900.0
Calcium %	4.20	4.08	3.88	3.75	3.64	3.49
T. Phos. %	.62	.61	.59	.56	.55	.53
Lysine %	1.28	1.20	1.13	1.06	1.00	.93
TSAA %	.75	.72	.67	.66	.64	.63

¹Diets in crumblized form.

APPENDIX F (continued)
LAYING PERIOD DIETS

Ingredient	Diet Identification ¹				
	M	N	O	P	Q
	-----Pounds per Ton-----				
Corn	1327.5	1340.9	1357.3	1369.7	1385.4
Soybean Meal	441.9	404.8	370.3	348.3	309.6
Wheat Midds	36.4	66.8	87.1	96.8	123.4
Limestone	160.8	154.2	152.7	153.4	148.4
Methionine	1.2	1.4	1.6	1.7	1.9
Dical Phos	21.2	20.9	20.0	19.1	18.9
Salt	5.0	5.0	5.0	5.0	5.0
Vit. premix	2.0	2.0	2.0	2.0	2.0
Min. premix	1.0	1.0	1.0	1.0	1.0
Poultry Fat					
Mold Inhibitor	2.0	2.0	2.0	2.0	2.0
Tracer	1.0	1.0	1.0	1.0	1.0
Choline Cl					.1
l-Lysine					1.3
Total	2000.0	2000.0	2000.0	2000.0	2000.0
Protein %	16.7	16.1	15.5	15.1	14.5
ME kcal/kg	2900.0	2900.0	2900.0	2900.0	2900.0
Calcium %	3.35	3.22	3.18	3.18	3.07
T. Phos. %	.52	.52	.50	.50	.49
Lysine %	.88	.83	.78	.75	.75
TSAA %	.62	.61	.59	.59	.58

¹Diets in crumblized form.

Data Collection Schedule and Procedures:

Egg Production--All eggs that had the potential of being marketed were credited toward the test unit's (replicate) egg production, regardless of the shell condition at the time of collection. All eggs were collected and recorded daily. Egg production was summarized at twenty-eight day intervals, and was calculated and reported on a hen-day basis.

Egg Weight--At twenty-eight day intervals, all eggs produced in the previous 24-hour period were weighed and sorted by size. Extra large, large, medium, small, and pee wee categories were defined as having a minimum weight of 27, 24, 21, 18 and < 18 ounces per dozen, respectively. Percentages of eggs within each size category, average egg weight (g), and egg mass (g) were calculated and reported.

Egg Quality--At twenty-eight day intervals, all eggs produced within the previous 24 hours were examined by candling light and graded according to current USDA standards for egg quality. Eggs were graded at the point of production with no handling prior to examination. Egg income was calculated using three-year regional average prices for farm value of eggs based on egg production and quality evaluation.

Feed Consumption--All feed offered for consumption was recorded for each unit. At twenty-eight day intervals, feed not consumed was weighed and feed consumption was calculated. Daily feed intake (kg/100 hens/day) was calculated and reported for each strain. Feed costs were based on average regional prices and were calculated and summarized for complete production cycles.

Mortality--All mortalities were recorded daily, categorized as to the cause, and obvious accidents were not included in reported mortalities.

Statistical Analyses and Separation of Means:

Analyses of variance were performed on all data. Separate analyses were conducted for white and brown egg strains. Significant differences ($P < .01$) within white and brown egg strains are noted by differing letters among columns of means. All data were subjected to ANOVA utilizing the GLM procedure of SAS, with main effects of strain, layer house, and density. First and second order interactions were tested for significance. Mean differences were separated via the PDIFF option of the GLM procedure.

DESCRIPTION OF DATA TABLE STATISTICS

First cycle performance of white egg and brown egg strains are shown on Tables 1-18.

Breeder (Strain):

Short identification codes of the breeder and strain of the stock were developed. See more complete information following data tables.

Layer House:

"Open" denotes performance in the curtain-sided flush facility. "Closed" denotes performance in the controlled environment high rise facility.

Population and Space Allocations:

<u>White Hens</u> <u>per Cage</u>	<u>Cage Size</u> <u>Width Depth</u>	<u>Floor Space</u> <u>per Bird</u>	<u>Feeder</u> <u>Space</u> <u>per Bird</u>	<u>Water</u> <u>Nipples</u> <u>per Cage</u>
6	61 cm x 35.5 cm	361 cm ² (56 in ²)	10.2 cm 4 in	3
6	82 cm x 35.5 cm	482 cm ² (74.7 in ²)	^{13.6} 10.2 cm 4 in 5.4	3
<u>Brown Hens</u> <u>per Cage</u>	<u>Cage Size</u> <u>Width Depth</u>	<u>Floor Space</u> <u>per Bird</u>	<u>Feeder</u> <u>Space</u> <u>per Bird</u>	<u>Water</u> <u>Nipples</u> <u>per Cage</u>
6	61 cm x 35.5 cm	361 cm ² (56 in ²)	10.2 cm 4 in	3
6	82 cm x 35.5 cm	482 cm ² (74.7 in ²)	^{13.6} 10.2 cm 4 in 5.4	3

Hen Housed Eggs per Bird:

The total number of eggs produced divided by the number of birds housed at 126 days.

Hen Day Egg Production:

The average daily number of eggs produced per 100 hens per day.

Egg Mass:

The average daily production of egg mass in grams per hen day.

Mortality:

The percentage of birds which died between 126 and 441 days of age. Mortality which occurred during the molt period were reported separately in Tables 13 to 16.

Feed Consumption:

The kilograms of feed consumed daily per 100 hens.

Egg Weight:

The average egg weight of period samples in grams per egg.

Egg Income:

The calculated income per hen housed at 126 days, from egg production using three-year regional average egg prices as follows:

<u>Grade</u>	<u>Size</u>	<u>Cents/Dozen</u>
A	Extra Large	79.2
A	Large	79.2
A	Medium	69.1
A	Small	57.4
A	Pee Wee	28.7
B	All	28.7
Cracks	All	41.9

Feed Cost:

The calculated feed cost per hen housed at 126 days, using average price per ton.

<u>Diets</u>	<u>Price Per Ton</u>
D	168.86
E	164.35
F	159.05
G	161.58
H	148.42
I	144.57
M	142.76
N	137.13
O	137.82
P	128.77
Q	139.76

Grade Information:

The average grade of eggs according to USDA grading standards.

Egg Size Distribution:

The proportion of the eggs falling into the following size categories:

<u>Size Category</u>	<u>Ounces/Dozen</u>
Pee Wee	< 18
Small	18 - 21
Medium	21 - 24
Large	24 - 27
Extra Large	> 27

Metric Conversions:

1 lb = 453.6 g

1 lb = .4536 kg

1 oz = 28.35 g

1 g = .03527 oz

1 kg = 2.204 lb

1 g = 1000 mg

1 kg = 1000 g

TABLE 1. EFFECT OF LAYING HOUSE ON PERFORMANCE OF WHITE EGG STRAINS,
30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Laying House	Feed Cons (kg/100 hens/d)	Feed Conver- (g egg/ g feed)	Eggs Per Bird Housed	Egg Produc- tion (HD%)	Egg Mass (g/HD)	Mortal- ity (%)	Age at 50% Pro- duction (Days)
Shaver (White)	Closed	12.0	.38	236.8	80.7	48.5	12.4	155
	Open	11.7	.39	230.3	79.6	48.4	14.1	156
	Average	11.8 ^{BC}	.38 ^C	233.5 ^{CD}	80.1 ^{BC}	48.4 ^{CD}	13.2 ^A	156
Hisex (White)	Closed	12.3	.39	236.5	79.3	48.9	6.8	148
	Open	12.1	.40	235.8	79.1	49.4	7.9	149
	Average	12.2 ^A	.39 ^{BC}	236.2 ^{BCD}	79.2 ^C	49.1 ^{BC}	7.3 ^{BC}	148
ISA/Babcock (B-300-A)	Closed	12.4	.41	247.3	83.4	51.2	9.9	144
	Open	11.9	.43	242.8	83.4	51.5	12.8	143
	Average	12.1 ^{AB}	.42 ^A	245.0 ^{AB}	83.4 ^A	51.3 ^A	11.3 ^{AB}	144
ISA/Babcock (B300-B)	Closed	12.2	.41	248.8	83.6	50.8	8.9	142
	Open	11.9	.43	247.7	84.4	51.6	10.2	141
	Average	12.0 ^{AB}	.42 ^A	248.3 ^A	84.0 ^A	51.2 ^A	9.5 ^{AB}	141
Hy-Line (W-36)	Closed	10.7	.42	242.1	79.8	47.5	3.3	155
	Open	10.5	.44	240.1	79.3	48.0	4.2	155
	Average	10.6 ^D	.43 ^A	241.1 ^{ABC}	79.5 ^C	47.8 ^D	3.7 ^C	155
H & N ("Nick Chick")	Closed	12.3	.39	236.9	81.5	51.0	11.7	153
	Open	12.1	.41	233.5	81.4	51.9	12.9	154
	Average	12.2 ^A	.40 ^B	235.2 ^{CD}	81.5 ^B	51.4 ^A	12.3 ^{AB}	153
Dekalb (Delta)	Closed	11.8	.40	222.5	80.5	50.0	17.7	154
	Open	11.7	.41	225.8	79.0	49.8	12.2	152
	Average	11.7 ^C	.40 ^B	224.2 ^E	79.8 ^C	49.9 ^B	15.0 ^A	153
Dekalb (XL-Link)	Closed	12.3	.38	231.3	80.2	49.4	12.2	152
	Open	12.1	.39	229.0	80.0	49.3	12.3	153
	Average	12.2 ^A	.39 ^C	230.2 ^{DE}	80.1 ^{BC}	49.4 ^{BC}	12.2 ^{AB}	153
All Strains	Closed	12.0	.40	237.8	81.1	49.7	10.4	150
	Open	11.8	.41	235.6	80.8	50.0	10.8	150
	Average	11.9	.41	236.6	80.9	49.8	10.6	150

A,B,C,D,E - Different letters denote significant differences (P<.01), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 2. EFFECT OF LAYING HOUSE ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF WHITE EGG STRAINS, 30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Laying House	Egg Weight (g/egg)	Pee Wee (%)	Small (%)	Medium (%)	Large (%)	Extra Large (%)
Shaver (White)	Closed	59.6	1.0	6.2 ^X	16.6	42.4 ^{STUV}	28.1 ^Z
	Open	61.3	0.6	0.5 ^Z	14.1	49.9 ^{RS}	32.8 ^{YZ}
	Average	60.4 ^{EF}	0.8	3.3	15.4 ^{AB}	46.2	30.4
Hisex (White)	Closed	61.4	0.9	5.4 ^{XY}	12.2	38.3 ^{UVWX}	43.2 ^{VWX}
	Open	62.7	0.5	0.5 ^Z	10.7	39.9 ^{UVWX}	47.5 ^V
	Average	62.1 ^{BC}	0.7	2.9	11.5 ^{CD}	37.6	45.3
ISA/Babcock (B-300-A)	Closed	61.2	0.2	5.3 ^{XY}	15.1	36.6 ^{VWXY}	39.8 ^{VWXY}
	Open	61.9	0.3	0.7 ^Z	12.2	49.1 ^{RS}	38.7 ^{WXY}
	Average	61.6 ^{CD}	0.3	3.0	13.6 ^{BC}	42.8	39.2
ISA/Babcock (B-300-B)	Closed	60.6	0.5	5.1 ^{XY}	15.2	41.6 ^{TUV}	35.8 ^{XYZ}
	Open	61.4	0.9	0.3 ^Z	11.9	50.0 ^R	35.2 ^{XYZ}
	Average	61.0 ^{DE}	0.7	2.7	13.5 ^{BC}	45.8	35.5
Hy-Line (W-36)	Closed	59.1	0.8	7.9 ^W	19.2	44.2 ^{RSTUV}	28.3 ^{YZ}
	Open	61.1	0.4	0.9 ^Z	15.8	45.0 ^{RSTU}	33.4 ^Z
	Average	60.1 ^F	0.6	4.4	17.5 ^A	44.6	30.9
H & N ("Nick Chick")	Closed	62.0	0.8	4.7 ^Y	12.2	33.8 ^{WXYZ}	46.2 ^{VW}
	Open	64.1	0.4	0.2 ^Z	7.1	29.9 ^{YZ}	62.1 ^U
	Average	63.0 ^A	0.6	2.4	9.6 ^D	31.9	54.2
Dekalb (Delta)	Closed	61.6	0.6	4.7 ^Y	13.9	33.4 ^{XYZ}	46.4 ^{VW}
	Open	63.3	0.7	0.4 ^Z	6.7	28.6 ^Z	56.7 ^U
	Average	62.4 ^{AB}	0.7	2.6	10.3 ^D	31.0	51.5
Dekalb (XL-Link)	Closed	61.2	1.1	5.6 ^{XY}	13.5	36.6 ^{VWXY}	41.9 ^{VWX}
	Open	62.0	0.9	0.7 ^Z	12.4	41.2 ^{UVW}	42.2 ^{VWX}
	Average	61.6 ^{CD}	1.0	3.2	12.9 ^{BC}	38.9	42.0
All Strains	Closed	60.8	0.7	5.6	14.7	38.4	38.7
	Open	62.2	0.6	0.5	11.4	41.7	43.6
	Average	61.6	0.7	3.0	12.9	40.1	41.2

A,B,C,D,E,F - Different letters denote significant differences (P<.01), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

T,U,V,W,X,Y,Z - Different letters denote significant strain x housing interactions (P<.01).

TABLE 3. EFFECT OF LAYING HOUSE ON EGG QUALITY, INCOME AND FEED COSTS OF WHITE EGG STRAINS, 30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Laying House	Grade A (%)	Grade B (%)	Cracks (%)	Loss (%)	Egg Income (\$/hen)	Feed Costs (\$/hen)
Shaver (White)	Closed	96.5	1.9	1.3	0.3	13.77	5.80
	Open	97.4	1.2	1.1	0.2	14.31	4.83
	Average	97.0 ^{AB}	1.6 ^{BC}	1.2 ^{BC}	0.2	14.04 ^{BC}	5.32 ^{BC}
Hisex (White)	Closed	95.5	2.8	1.5	0.3	14.64	6.07
	Open	95.6	2.1	1.9	0.4	14.74	5.20
	Average	95.6 ^C	2.5 ^A	1.7 ^{AB}	0.3	14.69 ^{AB}	5.64 ^A
ISA/Babcock (B-300-A)	Closed	94.6	2.8	2.3	0.3	14.78	6.06
	Open	96.2	2.1	1.4	0.2	15.49	5.00
	Average	95.4 ^C	2.5 ^A	1.9 ^A	0.3	15.13 ^A	5.53 ^{AB}
ISA/Babcock (B-300-B)	Closed	96.3	1.7	1.6	0.3	15.20	5.98
	Open	96.4	2.0	1.3	0.3	15.41	5.05
	Average	96.4 ^{ABC}	1.9 ^A	1.5 ^{ABC}	0.3	15.30 ^A	5.52 ^{AB}
Hy-Line (W-36)	Closed	98.0	0.8	0.9	0.3	15.03	5.36
	Open	97.0	1.0	1.2	0.8	14.46	4.58
	Average	97.5 ^A	0.9 ^B	1.0 ^C	0.5	14.74 ^{AB}	4.97 ^D
H & N ("Nick Chick")	Closed	96.3	2.3	1.1	0.3	14.43	5.89
	Open	96.0	2.3	1.4	0.4	14.80	4.99
	Average	96.2 ^{BC}	2.3 ^A	1.2 ^{BC}	0.3	14.61 ^{AB}	5.44 ^{AB}
Dekalb (Delta)	Closed	95.3	2.8	1.9	0.1	13.64	5.39
	Open	96.4	2.1	1.3	0.3	13.34	4.80
	Average	95.9 ^{BC}	2.4 ^A	1.6 ^{ABC}	0.2	13.49 ^C	5.10 ^{CD}
Dekalb (XL-Link)	Closed	95.6	2.2	1.6	0.6	14.09	5.89
	Open	96.2	1.7	1.9	0.3	14.07	5.01
	Average	95.9 ^{BC}	2.0 ^A	1.8 ^{AB}	0.4	14.08 ^{BC}	5.45 ^{AB}
All Strains	Closed	96.0	2.2	1.5	0.3	14.45	5.81
	Open	96.4	1.8	1.4	0.4	14.58	4.93
	Average	96.2	2.0	1.5	0.3	14.52	5.35

A,B,C,D - Different letters denote significant differences (P<.01), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 4. EFFECT OF DENSITY ON PERFORMANCE OF WHITE EGG STRAINS,
30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Density ¹ (cm ²)	Feed Cons (kg/100 hens/d)	Feed Conver- sion (g egg/ g feed)	Eggs Per Bird Housed	Egg Produc- tion (HD%)	Egg Mass (g/HD)	Mortal- ity (%)	Age at 50% Pro- duction (Days)
Shaver (White)	361	11.5	.39	228.5	79.0	47.4	16.0	156
	482	12.2	.38	238.6	81.3	49.5	10.5	155
Hisex (White)	361	11.8	.40	228.6	77.1	47.9	9.3	150
	482	12.7	.39	243.7	81.3	50.3	5.4	147
ISA/Babcock (B-300-A)	361	11.7	.42	239.8	81.7	50.2	10.5	145
	482	12.5	.42	250.3	85.2	52.4	12.2	143
ISA/Babcock (B-300-B)	361	11.7	.42	239.3	81.4	49.5	11.0	142
	482	12.3	.43	257.2	86.7	52.9	8.1	140
Hy-Line (W-36)	361	10.4	.43	238.9	78.4	47.1	3.1	155
	482	10.9	.42	243.3	80.6	48.5	4.4	155
H & N ("Nick Chick")	361	11.8	.40	227.9	79.6	50.0	14.9	155
	482	12.6	.40	242.5	83.3	52.9	9.6	152
Dekalb (Delta)	361	11.3	.41	219.8	77.6	48.7	13.0	154
	482	12.1	.40	228.6	81.9	51.1	16.9	152
Dekalb (XL-Link)	361	11.9	.39	230.6	79.1	48.6	12.6	152
	482	12.6	.38	229.7	81.1	50.1	11.9	153
All Strains	361	11.5 ^B	.41 ^A	231.7 ^B	79.2 ^B	48.7 ^B	11.3	151
	482	12.2 ^A	.40 ^B	241.7 ^A	82.7 ^A	51.0 ^A	9.9	150

A,B,C,D - Different letters denote significant differences (P<.01).

¹The following is the conversion from square centimeters to square inches: 361 equals 56 square inches; 482 equals 74.7 square inches.

TABLE 5. EFFECT OF DENSITY ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF WHITE EGG STRAINS, 30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Density ¹ (cm ²)	Egg Weight (g/egg)	Pee Wee (%)	Small (%)	Medium (%)	Large (%)	Extra Large (%)
Shaver (White)	361	60.0	1.2	3.6	15.5	46.0	27.0
	482	60.9	0.4	3.1	15.2	46.3	33.9
Hisex (White)	361	62.1	0.6	3.2	11.0	38.4	46.3
	482	62.0	0.8	2.7	12.0	39.8	44.3
ISA/Babcock (B-300-A)	361	61.5	0.1	2.8	14.5	43.4	38.1
	482	61.6	0.4	3.2	12.7	42.3	40.3
ISA/Babcock (B-300-B)	361	61.0	0.7	3.0	13.3	45.1	34.4
	482	61.1	0.6	2.4	13.7	46.5	36.6
Hy-Line (W-36)	361	60.1	0.7	4.0	17.3	45.1	29.9
	482	60.1	0.5	4.8	17.6	44.1	31.8
H & N ("Nick Chick")	361	62.5	0.6	2.7	11.1	33.6	49.7
	482	63.5	0.6	2.2	8.1	30.1	58.7
Dekalb (Delta)	361	62.7	0.4	2.6	9.7	30.7	52.6
	482	62.2	1.0	2.6	10.8	31.2	50.4
Dekalb (XL-Link)	361	61.4	0.9	3.4	12.9	38.6	39.2
	482	61.7	1.1	2.9	13.0	39.2	44.8
All Strains	361	61.4	0.6	3.2	13.2	40.1	39.7
	482	61.6	0.7	3.0	12.9	39.9	42.6

*There are no significant differences among these means.

¹The following is the conversion from square centimeters to square inches: 361 equals 56 square inches; 482 equals 74.7 square inches.

TABLE 6.

EFFECT OF DENSITY ON EGG QUALITY, INCOME AND FEED COSTS OF WHITE EGG STRAINS,
30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Density ¹ (cm ²)	Grade A (%)	Grade B (%)	Cracks (%)	Loss (%)	Egg Income (\$/hen)	Feed Costs (\$/hen)
Shaver (White)	361	97.0	1.6	1.3	0.1	13.28	5.07
	482	97.0	1.6	1.1	0.4	14.80	5.56
Hisex (White)	361	95.4	2.2	2.1	0.2	14.24	5.36
	482	95.7	2.7	1.2	0.4	15.15	5.91
ISA/Babcock (B-300-A)	361	95.4	2.1	2.1	0.4	14.84	5.32
	482	95.4	2.8	1.6	0.2	15.43	5.73
ISA/Babcock (B-300-B)	361	96.0	2.0	1.8	0.3	14.45	5.30
	482	96.8	1.7	1.2	0.4	16.16	5.73
Hy-Line (W-36)	361	97.4	0.7	1.4	0.5	14.48	4.86
	482	97.7	1.1	0.7	0.6	15.00	5.08
H & N ("Nick Chick")	361	96.2	2.3	1.3	0.3	13.98	5.19
	482	96.1	2.3	1.2	0.4	15.25	5.69
Dekalb (Delta)	361	96.1	1.9	1.7	0.3	13.27	4.94
	482	95.7	2.9	1.4	0.0	13.71	5.26
Dekalb (XL-Link)	361	95.6	2.2	2.0	0.3	13.64	5.32
	482	96.1	1.7	1.6	0.5	14.52	5.58
All Strains	361	96.1	1.9	1.7 ^A	0.3	14.02 ^B	5.17 ^B
	482	96.3	2.1	1.2 ^B	0.4	15.00 ^A	5.57 ^A

A,B - Different letters denote significant differences (P<.01).

¹The following is the conversion from square centimeters to square inches: 361 equals 56 square inches; 482 equals 74.7 square inches.

TABLE 7. EFFECT OF LAYING HOUSE ON PERFORMANCE OF BROWN EGG STRAINS, 30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Laying House	Feed Cons (kg/100 hens/d)	Feed Conver- (g egg/g feed)	Eggs Per Bird Housed	Egg Produc- tion (HD%)	Egg Mass (g/HD)	Mortal- ity (%)	Age at 50% Pro- duction (Days)
Hisex (Brown)	Closed	12.4	.36	226.9	75.5	48.7	7.0	156
	Open	12.5	.39	233.6	78.4	51.1	9.3	155
	Average	12.5 ^{BC}	.38 ^C	230.2 ^B	77.0 ^C	49.9 ^C	8.2 ^{AB}	156 ^A
ISA (Brown)	Closed	13.1	.41	245.7	3.1	54.2	10.6	144
	Open	12.6	.43	244.6	84.1	55.4	12.5	144
	Average	12.8 ^A	.42 ^A	245.1 ^A	83.6 ^A	54.8 ^A	11.5 ^A	144 ^C
Hy-Line (Brown)	Closed	12.6	.40	248.7	81.9	52.1	4.5	148
	Open	12.5	.41	245.5	81.2	52.1	4.7	150
	Average	12.6 ^B	.41 ^B	247.1 ^A	81.5 ^B	52.1 ^B	4.6 ^B	149 ^B
H & N ("Brown Nick")	Closed	12.3	.42	241.0	81.1	52.8	11.6	150
	Open	12.1	.43	241.5	80.7	53.2	9.0	149
	Average	12.2 ^C	.42 ^A	241.3 ^A	80.9 ^B	53.0 ^B	10.3 ^A	150 ^B
All Strains	Closed	12.6	.40	240.6	80.4	52.0	8.4	150
	Open	12.4	.42	241.3	81.1	53.0	8.9	150
	Average	12.5	.41	240.9	80.8	52.5	8.7	150

A,B,C,D,E - Different letters denote significant differences ($P < .01$), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 8. EFFECT OF LAYING HOUSE ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF BROWN EGG STRAINS, 30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Laying House	Egg Weight (g/egg)	Peewee (%)	Small (%)	Medium (%)	Large (%)	Extra Large (%)
Hisex (Brown)	Closed	63.9	0.6	2.8 ^W	9.3	27.7	59.8
	Open	65.4	0.5	0.1 ^Z	3.2	22.9	71.6
	Average	64.7 ^B	0.5	1.5	5.8 ^{AB}	25.3 ^{AB}	65.7 ^A
ISA (Brown)	Closed	65.1	0.5	1.0 ^Y	6.8	24.9	66.1
	Open	66.0	0.3	0.0 ^Z	1.6	22.1	74.8
	Average	65.6 ^A	0.4	0.5	4.2 ^B	23.5 ^B	70.4 ^A
Hy-Line (Brown)	Closed	63.5	0.4	2.2 ^{WX}	10.4	29.7	55.9
	Open	64.5	0.4	0.1 ^Z	3.9	28.8	64.5
	Average	64.0 ^C	0.4	1.2	7.2 ^A	29.3 ^A	60.2 ^B
H & N ("Brown Nick")	Closed	64.8	0.3	1.7 ^X	8.7	25.7	62.0
	Open	66.1	0.1	0.1 ^Z	2.6	22.4	71.7
	Average	65.4 ^A	0.2	0.9	5.7 ^{AB}	24.0 ^B	66.8 ^A
All Strains	Closed	64.3	0.4	1.9	9.0	27.0	61.0
	Open	65.5	0.3	0.1	2.8	24.1	70.7
	Average	64.9	0.4	1.0	5.6	25.5	66.0

A,B,C - Different letters denote significant differences (P<.01), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

T,U,V,W,X,Y,Z - Different letters denote significant strain x housing interactions (P<.01).

TABLE 9. EFFECT OF LAYING HOUSE ON EGG QUALITY, INCOME AND FEED COSTS OF BROWN EGG STRAINS, 30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Laying House	Grade A (%)	Grade B (%)	Cracks (%)	Loss (%)	Egg Income (\$/hen)	Feed Costs (\$/hen)
Hisex (Brown)	Closed	96.2	2.1	1.3	0.5	14.20	6.12
	Open	97.1	1.4	0.9	0.5	14.75	5.50
	Average	96.7	1.7	1.1	0.5	14.48 ^B	5.81 ^{AB}
ISA (Brown)	Closed	95.9	2.3	1.5	0.4	15.46	6.32
	Open	96.7	1.9	1.2	0.2	15.59	5.50
	Average	96.3	2.1	1.3	0.3	15.52 ^A	5.91 ^A
Hy-Line (Brown)	Closed	97.0	1.1	1.4	0.5	15.54	6.31
	Open	97.1	1.2	1.4	0.3	15.46	5.59
	Average	97.0	1.1	1.4	0.4	15.50 ^A	5.95 ^A
H & N ("Brown Nick")	Closed	96.5	2.2	1.2	0.1	15.05	6.03
	Open	96.8	1.4	1.5	0.4	15.09	5.29
	Average	96.7	1.8	1.3	0.2	15.07 ^{AB}	5.66 ^B
All Strains	Closed	96.4	1.9	1.4	0.4	15.06	6.20
	Open	96.9	1.5	1.3	0.4	15.22	5.47
	Average	96.7	1.7	1.3	0.4	15.15	5.81

A,B - Different letters denote significant differences ($P < .01$), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 10. EFFECT OF DENSITY ON PERFORMANCE OF BROWN EGG STRAINS,
30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Density ¹ (cm ²)	Feed Cons (kg/100 hens/d)	Feed Conver- sion (g egg/ g feed)	Eggs Per Bird Housed	Egg Produc- tion (HD%)	Egg Mass (g/HD)	Mortal- ity (%)	Age at 50% Pro- duction (Days)
Hisex (Brown)	361	11.9	.37	219.5	74.4	48.0	11.1	157
	482	13.0	.38	241.0	79.5	51.8	5.2	155
ISA (Brown)	361	12.4	.43	240.7	82.7	53.9	12.4	145
	482	13.3	.41	249.6	84.5	55.7	10.7	143
Hy-Line (Brown)	361	12.1	.41	239.1	79.0	50.4	5.1	150
	482	13.0	.41	255.1	84.1	53.9	4.0	148
H & N ("Brown Nick")	361	11.8	.43	233.7	78.4	51.3	10.6	151
	482	12.6	.42	248.9	83.5	54.7	10.0	148
All Strains	361	12.1 ^B	.41	233.3 ^B	78.6 ^B	50.9 ^B	9.8	151 ^A
	482	13.0 ^A	.41	248.6 ^A	82.9 ^A	54.0 ^A	7.5	149 ^B

A,B - Different letters denote significant differences (P<.01).

¹The following is the conversion from square centimeters to square inches: 361 equals 56 square inches; 482 equals 74.7 square inches.

TABLE 11. EFFECT OF DENSITY ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF BROWN EGG STRAINS, 30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Density ¹ (cm ²)	Egg Weight (g/egg)	Pee Wee (%)	Small (%)	Medium (%)	Large (%)	Extra Large (%)
Hisex (Brown)	361	64.3	0.4	1.8	6.0	26.8	63.9
	482	65.0	0.6	1.1	5.6	23.8	67.5
ISA (Brown)	361	65.2	0.4	0.6	4.4	25.8	66.7
	482	65.9	0.4	0.3	4.1	21.2	74.2
Hy-Line (Brown)	361	63.8	0.3	1.2	6.9	32.1	56.8
	482	64.2	0.6	1.2	7.4	26.5	63.5
H & N ("Brown Nick")	361	65.3	0.2	1.0	5.9	24.8	64.9
	482	65.5	0.2	0.8	5.4	23.2	68.8
All Strains	361	64.7 ^B	0.3	1.1	5.8	27.4 ^A	63.1 ^B
	482	65.2 ^A	0.4	0.9	5.6	23.7 ^B	68.5 ^A

A,B - Different letters denote significant differences (P<.01).

¹The following is the conversion from square centimeters to square inches: 361 equals 56 square inches; 482 equals 74.7 square inches.

TABLE 12.

EFFECT OF DENSITY ON EGG QUALITY, INCOME AND FEED COSTS OF BROWN EGG STRAINS
30TH NCLP&MT (133-441 DAYS)

Breeder (Strain)	Density (cm ²)	Grade A (%)	Grade B (%)	Cracks (%)	Loss (%)	Egg Income (\$/hen)	Feed Costs (\$/hen)
Hisex (Brown)	361	93.3	1.9	1.4	0.4	13.81	5.46
	482	97.0	1.6	0.8	0.6	15.15	6.16
ISA (Brown)	361	96.4	1.8	1.5	0.3	15.06	5.63
	482	96.2	2.4	1.2	0.3	15.98	6.19
Hy-Line (Brown)	361	97.1	1.2	1.5	0.2	14.89	5.72
	482	97.0	1.1	1.3	0.5	16.11	6.18
H & N ("Brown Nick")	361	96.3	2.0	1.5	0.3	14.42	5.40
	482	97.0	1.6	1.2	0.2	15.72	5.91
All Strains	361	96.5	1.7	1.5	0.3	14.54 ^B	5.55 ^B
	482	96.8	1.7	1.1	0.4	15.74 ^A	6.11 ^A

A,B - Different letters denote significant differences (P<.01).

¹The following is the conversion from square centimeters to square inches: 361 equals 56 square inches; 482 equals 74.7 square inches.

TABLE 13. EFFECT OF LAYING HOUSE ON SYNCHRONIZED MOLT OF WHITE EGG STRAINS, 30TH NCLP&MT (441-455 DAYS)

Breeder (Strain)	Laying House	Beginning Body Weight (kg)	Ending Body Weight (kg)	Weight Loss/Day (g)	Weight Loss (%)	Mortality (%)
Shaver (White)	Closed	1.99	1.37	27	31.2	1.9
	Open	2.06	1.44	28	30.1	2.3
	Average	2.03	1.41 ^A	28	30.6	2.1 ^{BC}
Hisex (White)	Closed	1.92	1.32	40	31.3	0.7
	Open	1.97	1.38	37	30.0	1.9
	Average	1.94	1.35 ^{AB}	38	30.6	1.3 ^{BC}
ISA/Babcock (B-300-A)	Closed	1.90	1.28	19	32.5	5.3
	Open	1.86	1.24	44	33.2	2.5
	Average	1.88	1.26 ^{BC}	31	32.8	3.9 ^{AB}
ISA/Babcock (B-300-B)	Closed	1.79	1.19	30	33.4	6.0
	Open	1.82	1.28	50	29.4	8.0
	Average	1.80	1.23 ^C	40	31.4	7.0 ^A
Hy-Line (W-36)	Closed	1.83	1.33	18	27.4	0.0
	Open	1.82	1.31	41	27.7	0.7
	Average	1.82	1.32 ^{ABC}	29	27.6	0.3 ^C
H & N ("Nick Chick")	Closed	1.95	1.32	28	32.4	3.2
	Open	1.96	1.37	32	30.4	0.7
	Average	1.95	1.34 ^{AB}	30	31.4	2.0 ^{BC}
Dekalb (Delta)	Closed	1.85	1.27	47	31.7	2.1
	Open	1.83	1.24	34	32.4	4.4
	Average	1.84	1.25 ^{BC}	40	32.1	3.2 ^{BC}
Dekalb (XL-Link)	Closed	1.87	1.27	37	31.9	3.0
	Open	1.98	1.42	22	27.6	2.0
	Average	1.92	1.35 ^{AB}	29	29.8	2.5 ^{BC}
All Strains	Closed	1.89	1.29	31	31.5	2.8
	Open	1.91	1.34	36	30.1	2.8
	Average	1.90	1.31	33	30.8	2.8

A,B,C - Different letters denote significant differences ($P < .01$), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 14. EFFECT OF DENSITY ON SYNCHRONIZED MOLT OF WHITE EGG STRAINS,
30TH NCLP&MT (441-455 DAYS)

Breeder (Strain)	Density (cm ²)	Beginning Body Wt. (kg)	Ending Body Wt. (kg)	Weight Loss/day (g)	Weight Loss (%)	Mortality (%)
Shaver (White)	361	2.02 ^{WX}	1.38	29	31.8	1.4
	482	2.03 ^{WX}	1.43	26	29.4	2.8
Hisex (White)	361	1.96 ^{WX}	1.32	30	32.8	0.7
	482	1.93 ^{WXY}	1.38	47	28.5	1.9
ISA/Babcock (B-300-A)	361	1.80 ^{YZ}	1.19	22	34.3	4.2
	482	1.95 ^{WXY}	1.34	41	31.4	3.7
ISA/Babcock (B-300-B)	361	1.72 ^Z	1.22	48	29.2	6.6
	482	1.88 ^{XYZ}	1.25	32	33.5	7.4
Hy-Line (W-36)	361	1.84 ^{YZ}	1.34	29	27.2	0.7
	482	1.80 ^{YZ}	1.30	30	27.9	0.0
H & N ("Nick Chick")	361	1.85 ^{YZ}	1.25	39	32.7	2.1
	482	2.05 ^W	1.43	22	30.2	1.9
Dekalb (Delta)	361	1.85 ^{YZ}	1.24	51	32.8	5.6
	482	1.84 ^{YZ}	1.27	30	31.3	0.9
Dekalb (XL-Link)	361	2.02 ^{WX}	1.38	21	31.4	3.1
	482	1.83 ^{YZ}	1.31	38	28.2	1.9
All Strains	361	1.88	1.29 ^B	34	31.5	3.0
	482	1.91	1.34 ^A	33	30.1	2.5

A,B - Different letters denote significant differences between densities (P<.01).

W,X,Y,Z - Different letters denote significant strain x cage interactions (P<.01).

TABLE 15. EFFECT OF LAYING HOUSE ON SYNCHRONIZED MOLT OF BROWN EGG STRAINS,
30TH NCLP&MT (441-455 DAYS)

Breeder (Strain)	Laying House	Beginning Body Weight (kg)	Ending Body Weight (kg)	Weight Loss/Day (g)	Weight Loss (%)	Mortality (%)
Hisex (Brown)	Closed	2.32	1.67	37	28.1	4.2
	Open	2.32	1.73	42	25.4	4.9
	Average	2.32	1.70 ^A	39	26.7	4.5
ISA (Brown)	Closed	2.16	1.53	48	29.3	3.2
	Open	2.21	1.58	23	28.5	2.3
	Average	2.18	1.55 ^B	36	28.9	2.8
Hy-Line (Brown)	Closed	2.41	1.68	34	30.3	6.0
	Open	2.32	1.62	34	30.3	4.9
	Average	2.36	1.65 ^{AB}	34	30.3	5.4
H & N ("Brown Nick")	Closed	2.24	1.59	38	28.9	5.1
	Open	2.27	1.63	35	28.4	4.6
	Average	2.25	1.61 ^{AB}	36	28.7	4.9
All Strains	Closed	2.28	1.62	39	29.2	4.6
	Open	2.28	1.64	34	28.2	4.2
	Average	2.28	1.63	36	28.6	4.4

A,B - Different letters denote significant differences ($P < .01$), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 16. EFFECT OF DENSITY ON SYNCHRONIZED MOLT OF BROWN EGG STRAINS,
30TH NCLP&MT (441-455 DAYS)

Breeder (Strain)	Density (cm ²)	Beginning Body Wt. (kg)	Ending Body Wt. (kg)	Weight Loss/day (g)	Weight Loss (%)	Mortality (%)
Hisex (Brown)	361	2.26	1.64	51	27.0	3.5
	482	2.38	1.75	27	26.5	5.6
ISA (Brown)	361	2.12	1.51	26	29.0	3.7
	482	2.25	1.60	46	28.8	1.9
Hy-Line (Brown)	361	2.33	1.58	33	32.0	3.5
	482	2.41	1.72	35	28.6	7.4
H & N ("Brown Nick")	361	2.20	1.58	38	27.9	4.2
	482	2.31	1.63	34	29.4	5.6
All Strains	361	2.23 ^B	1.58 ^B	37	29.0	3.7
	482	2.34 ^A	1.67 ^A	36	28.3	5.1

A,B - Different letters denote significant differences (P<.01).

Cause of Mortality in the 30TH NCLP&MT as Expressed by Percent of Total Mortality

White Egg Strains	Prolapse ¹	Normal ²	Decomposed ³	Molt ⁴
Shaver (White)	77.8	10.3	.8	11.1
Hisex (White)	52.5	23.7	1.3	22.5
ISA/Babcock (B-300-A)	52.0	18.1	3.1	26.8
ISA/Babcock (B-300-B)	43.4	14.0	2.2	40.4
Hy-Line (W-36)	41.9	45.1	6.5	6.5
H & N ("Nick Chick")	61.3	21.9	2.5	14.3
Dekalb (Delta)	65.9	13.9	2.8	17.4
Dekalb (XL-Link)	73.7	13.1	.9	12.3
Brown Egg Strains	Prolapse ¹	Normal ²	Decomposed ³	Molt ⁴
Hisex (Brown)	48.2	11.6	4.5	35.7
ISA (Brown)	52.2	18.5	4.3	25.0
Hy-Line (Brown)	40.0	20.0	4.6	35.4
H & N ("Brown Nick")	49.3	14.4	4.5	31.8

¹Prolapse includes mortalities attributed to cannibalism and/or expulsion of viscera from cloacal opening.

²Normal includes mortalities which show no outward signs of causation.

³Decomposed mortalities are those which were found late and decomposition would not allow identification of cause.

⁴Molt are those mortalities which occurred during the fasting phase of the synchronized molt program.