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Characterization of Quail Egg Production by Using a Multiphasic Analysis under Selection for Egg Number

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Abstract. A multiphasic function that considers egg production of individual hens to result from more than one phase was used to describe egg production for Quail. Hens of two generations were used to characterize egg production. Selection for egg number was done in the foundation stocks to produce the first selected generation. Daily time of oviposition was recorded. Results indicated that hens of the first selected generation had shorter circadian rhythms (shorter than 24 h) and their lag were ranged from − 1.83 to − 0.32 h. Delay averages were ranged from 26.51 to 36.58 h for hens of the base population, while they were ranged from 23.11 to 31.42 h for hens of the first selected generation.

Introduction

Koops and Grossman [1] described egg production for an individual hen by a multiphasic model, where each phase is determined by the number of eggs within a clutch, including internally laid eggs and the pause between clutches. Also number of eggs in a clutch is determined by circadian rhythm, which consists of daily rhythm and lag. Internal laying is a result of asynchrony in the development of the oviduct and the ovary.

Pause consists of a circadian rhythm and a period called delay. And both lag and internal laying are more controlled genetically than delay which is more controlled by environment, such as light dark ratio [2].

A multiphasic model was developed to characterize egg production by lag and delay, expressing cumulative egg number in terms of time. The model assumed no internal laying, however, the model still can be used if data are adjusted for internal laying prior to the analysis. Koops and Grossman [1] developed an equation for estimate lag and delay. Data of Koops and Grossman [1] in fowl and that of Aggrey *et al.* [3] in Quail characterized egg production for laying hens without selection influence on egg production. Therefore, the present study was aimed to investigate and characterize egg production of Quail hens under selection pressure for egg number.

Material and Methods

Three Japanese Quail hens at 8 weeks of age, were housed in individual cages (15 cm wide, 20 cm long, and 20 cm high). This number of birds was used because it was the maximum accurate number that could be monitored by the video camera without compromising resolution. Feed and water were provided ad libitum and maintenance care was done between 0600 - 0900 h. Room temperature was maintained at 20°C. Light intensity was maintained at about 50 LX. Hens were reared under photo-regime of 14 h light: 10 h dark, with hours of light between 0600 and 2000 h. The exact time of oviposition was individually recorded by means of a video recording system (VRS). Observation was done by a time-lapse video records connected with two low light intensity television cameras. The VRS continuously recorded oviposition of the three hens all day long. Similar finding was observed by Aggrey *et al.* [3]. Selection for egg number during the first month of laying was made according to individual performance. Then the selected hens were mated (with random males) to obtain the first selected generation. When chicks reached sexual maturity, 3 hens were chosen at random and oviposition time was recorded by the same video recording system (VRS). Environmental conditions in the two generations were kept constant.

Recording was done for 13 days for the base population (F) and for 17 days for the first selected generation (G1). This short period of observation was more accurate estimate for lag. Gilbert [4, p.2-21] reported that an accurate estimate of lag requires only a short period of observation, especially as equipment becomes available to record time of oviposition more precisely. Based on the frequency distribution of internally laid eggs over a laying periods lag would be expected to be constant over the period when data are preadjusted for internal laying.

The multiphasic function used to describe the egg production curve was derived by Koops and Grossman [1]:

$$t_y = (24 + \lambda)(Y - 1) + \delta(c - 1),$$

where t_y is the observed time of oviposition in hours from the time of first recorded egg for cumulative egg number (Y), λ is average lag in hours, δ is average delay in hours, and c is the sequence number of the clutch. Lag is the clockwise difference in times of day of one oviposition with respect to its predecessor and delay is the time lapse from oviposition of the last egg of a clutch to the oviposition of the first egg of the next clutch minus 24 h. Delay is an approximate measure of the period of lapse in the ovulatory cycle. When there was no egg in a particular day and the egg laying time of the previous day and the following day were quite similar (i.e., that day was not preceded by an egg laid late on the previous day or followed by an egg laid early in the afternoon on the following day), an internally laid egg was assumed to have occurred. The data, therefore, were preadjusted for internal laying prior to analysis. An internal egg was assigned to the same clutch as the previous and the following egg [1].

Results and Discussion

Table 1 and 2 present clock time of oviposition of the three hens in base population and the first selected genearation. For hen 1 in the foundation stock for example, there was a pause on day 7, but this pause was not preceded by an egg laid late in the day or followed by an egg laid early in the afternoon, so it was assumed that there was an internally laid egg on day 7. Therefore, internally laid egg on day 7 was assumed

Table 1. Observed clock-time (h) of oviposition by hen and day in foundation stock (F)

Day	Hen 1	Hen 2	Hen 3
1	1009	0634	0651
2	1233	0638	0936
3	1332	0702	1151
4	N	0628	N
5	1726	N	1415
6	0659	0659	1540
7	I	0908	N
8	0919	1228	N
9	0649	1259	1005
10	0701	1450	0701
11	N	1050	N
12	N	I	N
13	0841	2028	1948

N = no. egg; I = Internally laid egg.

Table 2. Observed clock-time (h) of oviposition by hen and day in the first selected generation (G1)

Day	Hen 1	Hen 2	Hen 3
1	1738	1556	1720
2	1730	1612	1720
3	1700	1622	1720
4	1701	1646	1641
5	1726	1552	N
6	1629	1451	N
7	1552	1442	1619
8	1632	1403	1410
9	N	1444	1209
10	1545	1459	1513
11	1554	1535	1040
12	1634	1604	1604
13	1653	1611	1636
14	1643	1546	N
15	1640	N	1552
16	1913	1635	1605
17	1745	1944	1608

N = no. egg

to have occurred and assigned to the same clutch. Similar internally egg was observed for hen 2 on day 12.

Clutch number and cumulative number of eggs (y1) were obtained in Tables 3 and 4 for both foundation stock and the first selected generation. It is clear that hens of the first selected generation had little clutch numbers with more eggs than those of the foundation stock. This may be due to selection effect for egg number.

Table 5 illustrates lag and delay estimates, and also showed clutch number and size for each hen in both generations. Lag (λ) ranged from $-$ 2.27 to + 0.54 h in the foundation stock and from $-$ 1.83 to $-$ 0.32 h in the selected generation. Values greater than 0 ($\lambda > 0$) indicate periods of circadian rhythm longer than 24 h. Negative values indicate circadian rhythms shorter than 24 h. This means that hen 1 in the foundation stock had the shortest circadian rhythms ($\lambda = -2.27$). In the same generation hen 3 had the longest circadian rhythms ($\lambda = +0.54$) or more than 24 h.

Table 3. Observed time of oviposition (t), in hours from time of first recorded egg, and number of clutch (c) by hen and cumulative number of egg (y) in the foundation stock (F)

	Hen 1		Hen 2		Hen 3	
Day	t	clutch no.	t	clutch no.	t	clutch no.
1	0	1	0	1	0	1
2	26.2	1	24.0	1	26.9	1
3	51.2	1	48.6	1	53.0	1
4	N	p	96.0	1	N	P
5	103.2	2	N	P	103.6	2
6	123.5	2	120.3	2	128.9	2
7	147.5(I)	2	146.7	2	N	P
8	168.9	2	173.9	2	N	P
9	195.9	2	198.3	2	195.5	3
10	219.1	2	224.2	2	216.5	3
11	N	P	244.2	2	N	P
12	N	P	268.2(I)	2	N	P
13	289.6	3	301.4	2	300.9	4

N = no. egg
I = internally egg
P = pause.

All the three hens in the first selected generation had shorter circadian rhythms (shorter than 24 h), where their lag were ranged from −1.83 to −0.32. It was noticed that hens of (G1) had no internally eggs, while two hens from the 3 studied hens in the foundation stock and internally laid eggs. Koops and Grossman [1] reported that internally laying limits egg production and attention should be paid to the function of the infundibulum and how it is influenced by selection for egg production. Also, they added that until egg production data is corrected for internal laying, the number of eggs laid in a clutch can not be a good indicator for an ovulatory sequence. Therefore, lag is a more useful trait for selection than number of eggs. This is because lag is expressed on a continuous scale, whereas number of eggs is expressed on a discrete scale, so that, there is a phenotypic variation for lag, even when there is no variation for number of eggs.

Average delay estimates for hens 1,2 and 3 in the foundation stock were 34.51, 26.51 and 36.51 h, respectively. The corresponding values in the first selected generation were 23.13, 23.11 and 31.42 h, respectively. Hens of the first selected generation had shorter delay estimates than those of the foundation stock. This may be due

Table 4. Observed time of oviposition (t), in hours from time of first recorded egg, and number of clutch (c) by hen and cumulative number of egg (y) in the first selected generation (G1)

	Hen 1		Hen 2		Hen 3	
Day	t	clutch no.	t	clutch no.	t	clutch no.
1	0	1	0	1	0	1
2	23.92	1	24.6	1	24.0	1
3	47.6	1	48.7	1	48.0	1
4	71.6	1	72.9	1	71.2	1
5	95.9	1	95.9	1	N	P
6	118.9	1	118.9	1	N	P
7	142.1	1	145.9	1	142.9	2
8	166.9	1	166.5	1	164.9	2
9	N	P	196.9	1	186.9	2
10	214.1	2	215.0	1	213.9	2
11	238.2	2	239.8	1	233.2	2
12	262.9	2	264.5	1	262.8	2
13	287.2	2	288.6	1	287.1	2
14	311.1	2	311.9	1	N	P
15	335.0	2	N	P	334.3	3
16	361.8	2	360.8	2	358.9	3
17	384.1	2	387.9	2	382.9	3

N = no. egg
P = pause.

Table 5. Estimates of lag (λ) and delay (δ) of foundation stock (F) and the first selected generation (G1)

Generation	Hen	Clutch no.	Clutch size	Lag (λ)	Delay (δ)	Egg. number	Egg rate %
F	1	3	3.0	− 2.27	34.51	9	69.23
	2	2	6.0	− 1.05	26.51	11	84.62
	3	4	1.7	+ 0.54	36.58	8	61.54
Average of 3 hens		3	3.6	− 0.54	32.5	9.3	71.80
G1	1	2	8.0	− 0.32	23.13	16	94.12
	2	2	8.0	− 0.48	23.11	16	94.12
	3	3	4.3	− 1.83	31.42	14	82.35
Average of 3 hens		2.3	6.7	− 0.88	25.89	15.3	90.20

$t_y = (24 + \lambda)(Y - 1) + \delta(c - 1)$ where,
t_y is the observed time from time of first recorded egg for cumulative egg number (Y), c is the sequence number of the clutch, λ is average lag in hours and δ is average delay in hours.

to selection. Fraps [5, p.661-740] reported that the number of ovipositions within an oviposition cycle has been shown to be inversely related to delay. Therefore, selection for either clutch size of lag will have a correlated response on delay. Similar delay estimates were obtained by Aggrey *et al.* [3].

Clutch number was decreased by selection (Table 5), while clutch size was increased 2 times for hens in generation 1 than that obtained for hens in the foundation stock. These effects may be due to selection for egg number. Lag was negatively correlated to average length of clutch and positively correlated to number of clutches [1].

In general, increasing egg production by selection can be explained by:

1. Decreasing oviposition internal within sequences.
2. Resulting longer sequences and lower frequent pause days.
3. Decreasing the frequency of missing eggs within sequences.

References

[1] Koops, W.J. and Grossman, M. "Characterization of Poultry Egg Production Using a Multiphasic Approach." *Poultry Science,* 71 (1972), 399-405.

[2] Lillpers, K. "Genetic Variation in the Time of Oviposition in the Laying Hen." *British Poultry Science,* 32 (1991), 303-312.

[3] Aggrey, S.E., Nichols, C.R., and Cheng, K.M. "Multiphasic Analysis of Egg Production in Japanese Quail." *Poultry Science,* 72 (1993), 2185-2192.

[4] Gilbert, A.B. *Egg Formation and Production,* Edinburgh, Scotland: British Poultry Science Ltd., 1972.

[5] Fraps, R.M. *Egg Production and Fertility in Poultry,* Hamond. (Ed.), London: Butterworths, 1955.

توصيف إنتاج البيض في السمان باستخدام التحليل متعدد المراحل تحت الانتخاب لعدد البيض

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ملخص البحث. الدالة المتعددة المراحل التي تعتبر أن إنتاج البيض يتكون من أكثر من مرحلة استخدمت لوصف إنتاج البيض في السمان. استخدمت إناث من جيلين لتوصيف إنتاج البيض، أجرى الانتخاب لعدد البيض في الجيل الأساسي لإنتاج أفراد الجيل الانتخابي الأول، تم تسجيل ميعاد الإباضة اليومي.

بينت النتائج أن إناث الجيل الانتخابي الأول كانت أقصر في مدة التباطؤ (أقل من **٢٤** ساعة) حيث كانت المدة تتراوح بين -١,٨٣ إلى -٠,٣٢، مدة التوقف بين السلاسل بلغت في المتوسط **٢٦,٥١ - ٣٦,٥٨** ساعة في الجيل الأساسي بينما في الجيل الانتخابي الأول كانت تتراوح بين **٢٣,١١ - ٣١,٤٢** ساعة.