The Effect of Ahemeral Light and Dark cycles on the Performance of Laying Hens—*(A Review)*

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Introduction

During the past decade research work has indicated that ahemeral cycles could markedly influence egg production, shell quality and egg weight. The major advantages of such cycles are that they can be easily applied and are reversible. This paper examines and reviews the published information in an attempt to summarize the effect of such cycles on the birds' laying performance.

Table 1 shows a list of the reports used for the present purpose. In two reports (Morris, 1979, and Reading University, 1973) the application of the ahemeral cycles affected age at sexual maturity, therefore the first few weeks of the measurement periods were omitted. The experiment by Rosales, Biellier and Stephenson (1968) was not used since they divided their birds into groups according to their interval between ovipositions.

TABLE 1: List of reports used to examine the effect of cycle length on laying performance

Author(s)	Age at Start of Treatments (wks)	Measurement Period (wks)	Cycle Length (h)
Cooper & Barnett (1976)	36	2	26, 28 & 30
Foster (1968)	20	4×3 wks	23 & 25
Foster (1969)	20	3×3 wks	26 & 28
King *et al* (1977)	70	4	28
Lacassgne & Sauveur (1973) Expt. 1	130d after SM[1]	2.3	26
Lacassgne & Sauveur (1973) Expt. 2	80d after SM[1]	2.5	28
Leeson *et al* (1979)	62	8	28
Michie (1980)	19	49	28
Morris (1978) Expt. 2	26	5	27
Morris (1979) Expt. 1 Treat. 1, 2 & 3	20	52	27
Morris (1979) Expt. 1 Treat. 4	20(30)[2]	42	27
Expt. 2	37	7	21, 27 & 30
Morris & Fox (1971)	30	22	25, 26 & 27
Poultry Testing (1975)	78	6	28
University of Reading (Unpublished) (1971)	20	42	27 & 30
(1972)	33	6	23, 27, 30 & 33
(1973)	20(25)[2]	10	27
(1974)	34	28	30
Yannakopoulos & Morris (1979)	64	10	28

[1] SM = sexual maturity
[2] Age at start of measurement period

Bearing in mind the variation between reports (Table 1) in respect to the age at start of treatments, the length of measurement period and the difference in effective

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photoperiod between the 24h and the non 24h (Morris, 1978), the weighted average for each cycle was used to find the general relationship between the traits under study and cycle length.

Effect on Rate of Lay and Egg Weight

Figure 1 shows the regression on cycle length of rate of lay and egg weight each expressed as a percentage of performance under a 24h cycle. It is clear that these two traits have a curvi-linear relationship with cycle length. Cycle length affects the number of eggs laid by restricting it to one egg/cycle and this in turn alters egg size. With cycles shorter than 24h, the number of eggs declines almost linearly for cycles between 24 and 21h. With cycles longer than 24h, rate of lay remains almost the same when birds are placed under 25h cycles, but it declines linearly as the cycle gets longer up to 33h cycles. If cycle length exceeds 33h, the birds will cease to be entrained (definition and measurement of entrainment have been discussed by Bhatti and Morris (1978)) and their rate of lay would sharply increase. To explain this point, 36h cycles will be used as an example. With 36h cycles, birds would add up two cycles together and treat them as three normal 24h cycles and instead of laying every 36 hours they will lay as normal every 24 to 25 hours (Bieller and Ostmann, 1960).

The increase in egg size following the use of ahemeral cycles was found to be associated with the extra time spent in the oviduct. Melek *et al.,* (1973) showed that under cycles longer than 24h, the interval from oviposition to ovulation increases by some 6.7m for every hour increase in mean intra-clutch interval between ovipositions and that the time required to enclose the yolk after ovulation also increases as the cycle length increases. Mean times spent in the upper oviduct and the shell gland were estimated to be 5.2h and 19.7h for the 24h cycles and 5.4h and 20.7h for the 27h cycles. Morris., (1973) presented evidence that both yolk weight and albumen weight are increased by the use of 27h cycle and it may be that the extra time spent in the magnum is a function of increased yolk size.

Effect on Egg Output

It can be seen from Figure 1 that for cycles between 26h and 28h, the reduction in rate of lay is not as great as the increase in egg size, hence by combining the results of rate of lay and egg weight, egg output under these cycles is slightly higher than that under normal 24h cycles (Figure 2). On the other hand, the reduction in rate of lay for cycles longer than 28h or shorter than 24h is greater than the increase in egg size and so egg output under such cycles is lower than that under 24h cycles.

Effect on Shell Quality and Abnormal Eggs

Eggs laid under 27h and 28h cycles have shells which are some 6-8% (Fox *et al.,* 1971 and Shanawany 1981) or 8-10% (Leeson *et al.,* 1979, Michie, 1980 and Yannakopoulos and Morris, 1979) thicker than those laid under normal 24h cycles, respectively. In addition to the improvement in shell quality, the percentage of abnormal eggs is also reduced. Research work at Reading University has shown that, on average, a reduction of 4% in the number of shell-less and cracked eggs can be readily obtained under 27h and 28h cycles (Shanawany, 1981 and Yannakopoulos and Morris, 1979).

Entrainment

All cycles listed in Table 1 are cycles based on alternating periods of light and dark, but for practical purposes an alternative system, which avoids the need for total darkness in the poultry house, is the use of cycles of bright light and dim (or blue) light. Morris and Bhatti (1978) illustrated the general principle that the signal needed to entrain the hen must be made stronger when the imposed cycle departs further, in

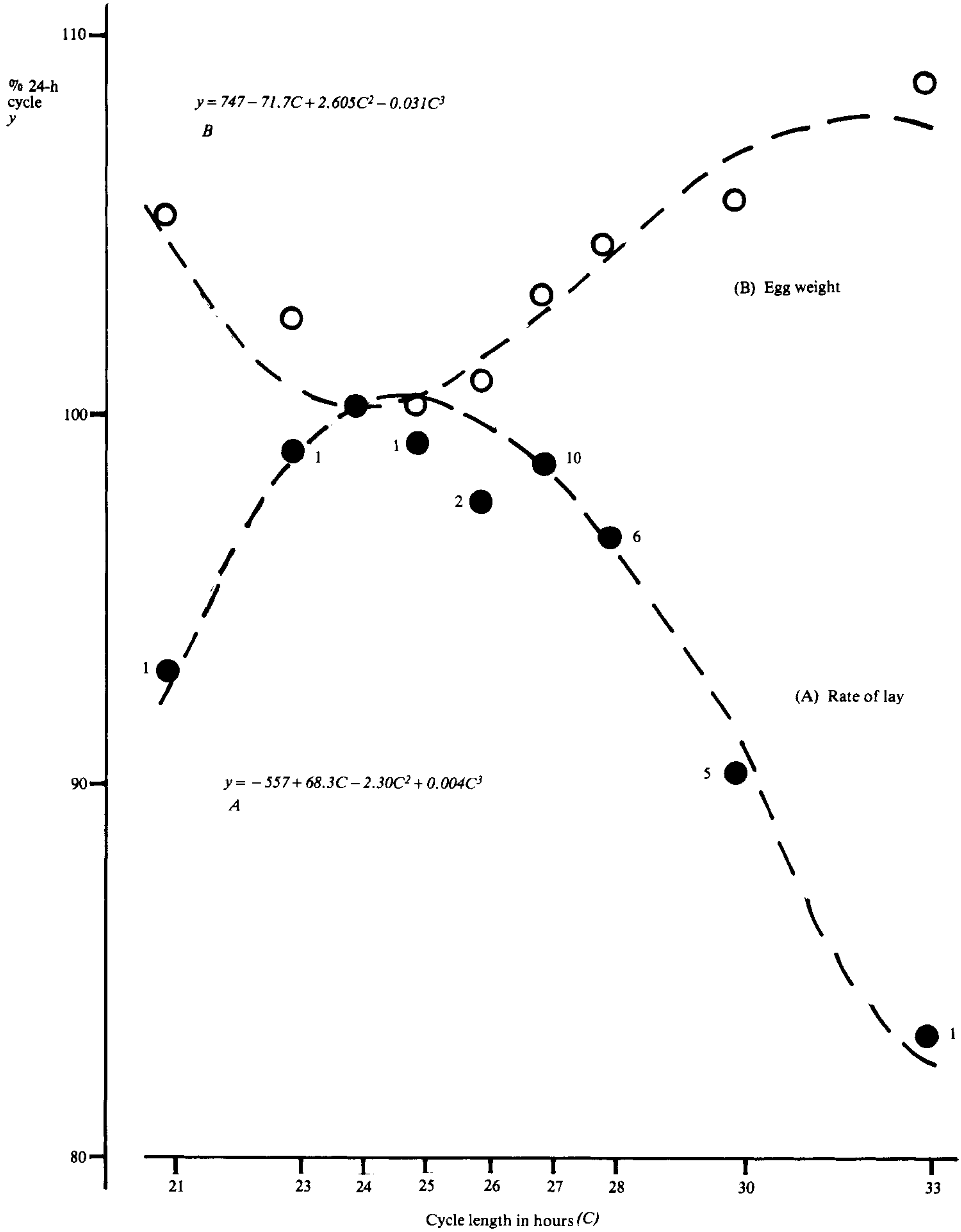

Figure 1: The relationship between either rate of lay (A) or egg weight (B) and cycle length (C). Values shown are number of treatments used to calculate the average for each cycle.

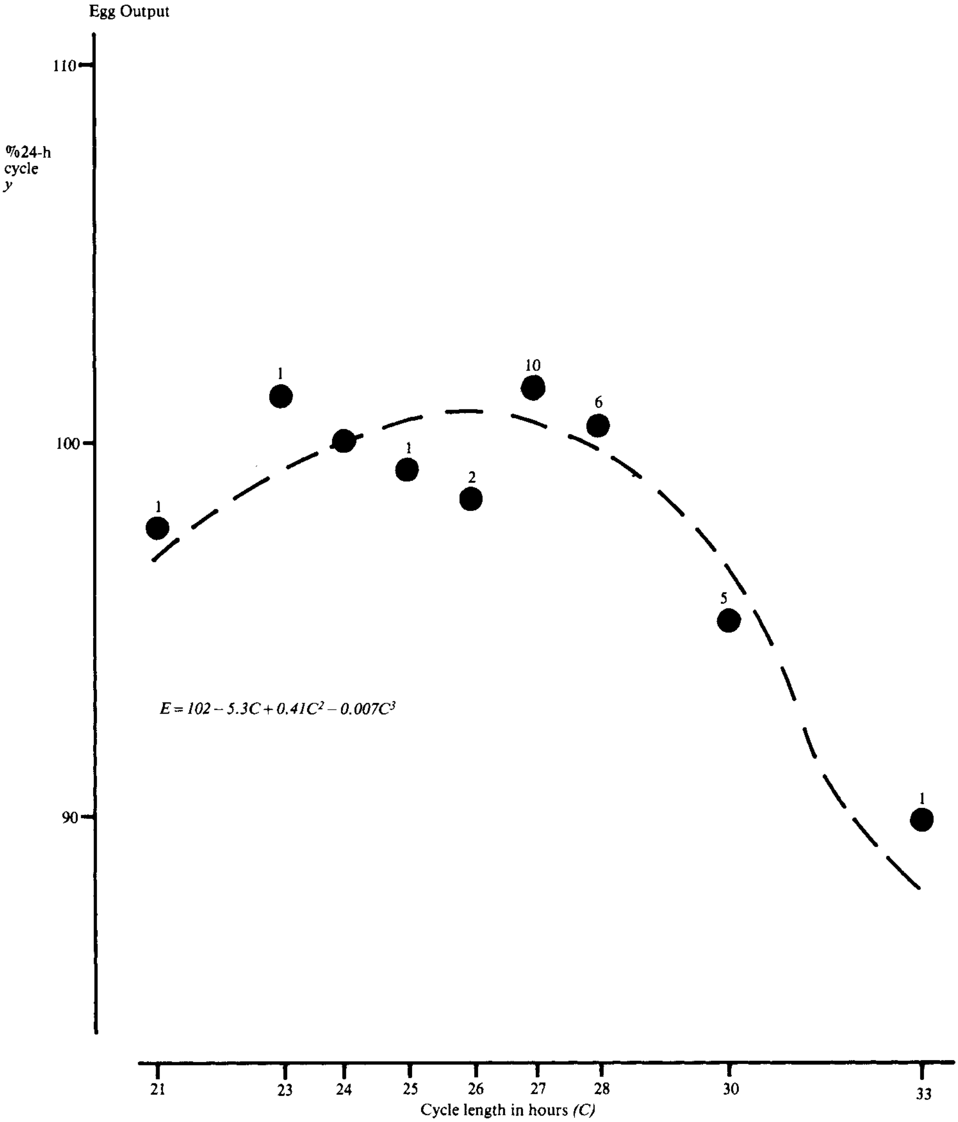

Figure 2: The relationship between egg output (E) and cycle length (C). Values shown are number of treatments used to calculate the average for each cycle.

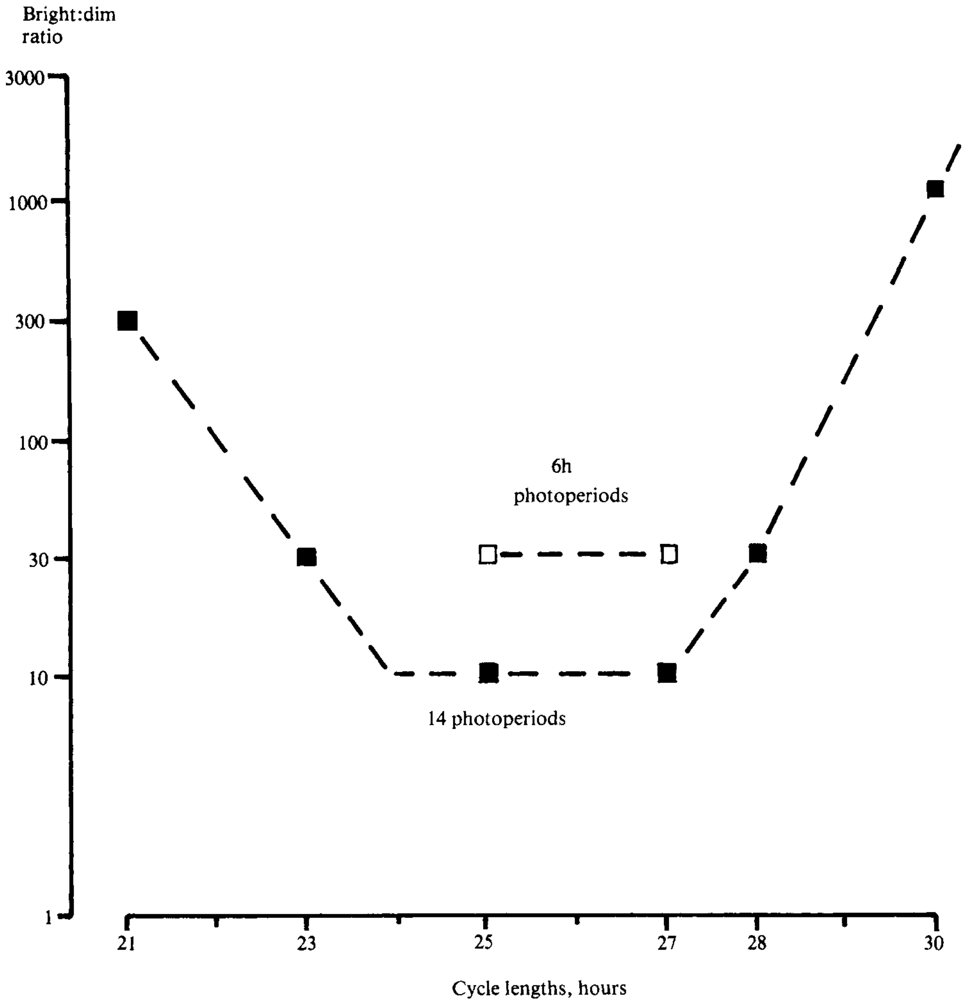

Figure 3: Ratio of bright:dim light intensities required to cause full entrainment of oviposition in cycles of different lengths (from Morris and Bhatti 1978).

either direction, from the biological norm of 24h (Figure 3). It has also been shown by these authors that when the bright period used in a 25h or 27h cycle was reduced to 6h, the bright:dim ratio needed to achieve full entrainment of oviposition appeared to be wider than that needed when a 14h bright period is used. It was concluded, therefore, that it is probably the case that, for any given cycle length, the bright:dim ratio must be widened to achieve entrainment as the duration of bright period approaches the minimum, or the maximum, value which gives entrainment under light-dark conditions.

When a flock is transferred to a long cycle, it responds as if it had been exposed to a photoperiod equal to p + (c-24) hours, where p is the actual photoperiod (h) and c is cycle length (h) (Morris, 1978). Accordingly, a flock transferred from 16L:8D to 16L:11D responds in the same way as though the photoperiod had been increased to 19 hours and, in most cases, increases its egg yield slightly. Conversely a flock taken from 16L:11D back to 16L:8D responds as though it had received a 3-hour cut in photoperiod and egg yield is likely to decline.

The magnitude of the response to ahemeral cycles is also influenced by the birds' age (i.e. their rate of lay) at which the change in cycle length is made. The reduction in rate of lay following the use of a long cycle, for example, at 50 weeks of age, will not be as great as that obtained when the same cycle is used during peak production.

For these reasons and for the prediction of rate of lay or egg output under different cycles, an extra term(s) should be added to the equations shown in Figures 1 and 2 to allow for the change in effective photoperiod ($\triangle$ p) between the ahemeral and 24h cycle and also to allow for the age at which the change to the ahemeral cycle is made.

Summary

Pooled results from 15 published and 5 unpublished experiments are used to find the general relationship between length of light-dark cycle light cycles—ranging from 21 to 33h—and the laying performance of the birds.

Cycle length affects the maximum frequency of oviposition by restricting it to one egg per cycle and thus alters egg size. With cycles shorter than 24h or longer than 25h, rate of lay declines almost linearly up to 33h cycles. Mean egg weight increases roughly in proportion to the decrease in rate of lay. Beyond 28h cycles, egg output is consistently lower than for controls on 24h cycles.

Improvement in shell quality in the order of 6-10% can be expected following the use of 27h or 28h cycles.

Résumé

EFFET D'UN CYCLE LUMINEUX AHÉMÉRAL SUR LES PERFORMANCES DES POULES PONDEUSES.

(M. M. Shanawany)

Les résultats regroupés de 15 expériences publiées et 5 non publiées sont utilisées pour rechercher une relation générale entre le cycle lumineux-allant de 21 h à 33 h- et les performances de ponte.

La longueur du cycle affecte la fréquence maximum d'oviposition en la restreignant à un oeuf par cycle, et par là, elle modifie le poids des oeufs. Avec des cycles plus courts que 24 h ou pluslongs qui 25 h., le taux de ponte décroît, la décroissance étant presque linéaire jusqu'aux cycles de 33 heures. Le poids moyen des oeufs augmente à peu près en proportion de la diminution du taux de ponte. Au-delà de 28 heures, la production d'oeufs est constamment inférieure à celle de témoins en cycles de 24 heures.

Une amélioration de la qualité des coquilles de l'ordre de 6 à 10 p.cent peut être attendue de l'emploi des cycles de 27 ou 28 heures.

Zusammenfassung

ÜBER DIE WIRKUNG EINER VERÄNDERTEN LÄNGE DES TAG-NACHT-ZYKLUS AUF DIE LEISTUNG VON LEGEHENNEN
(M. M. Shanawany)

Die zusammengefaßten Ergebnisse aus 15 veröffentlichten und 5 unveröffentlichten Versuchen wurden herangezogen, um den allgemeinen Zusammanhang zwischen der Zyklus-Länge und der Legeleistung von Hühnern zu untersuchen. Die Zyklus-Länge schwankte von 21-33 Stunden.

Die Zyklus-Länge beeinflußt die maximal mögliche Häufigkeit der Eiablage, denn diese ist auf ein Ei pro Zyklus beschränkt und verändert gleichzeitig die Eigröße. Eine Abnahme oder Zunahme der Zyklus-Länge gegenüber einem Standardtag von 24 Stunden führt in beiden Fällen zu einer fast geradlinigen Abnahme der Legetätigkeit. Das mittlere Eigewicht erhöht sich etwa proportional zur Abnahme der Legerate. Bei der Länge eines Zyklus von mehr als 28 Stunden ist der Eieranfall ausnahmslos geringer als bei einer 24stündigen Zyklus-Länge. Eine Verbesserung der Eischalenqualität von 6-10% tritt ein, wenn die Zyklus-Länge auf 27 oder 28 Stunden erhöht wird.

РЕЗЮМЕ

ВЛИЯНИЕ СВЕТОВОГО ЦИКЛА НА ПРОДУКТИВНОСТЬ КУР-НЕСУШЕК
(М.М.Шанавани)

Результаты 15 опубликованных и 5 неопубликованных экспериментальных работ используются для выявления общей взаимосвязи между световыми циклами от 21 до 33 часов и продуктивностью кур-несушек. Продолжительность светового цикла влияет на максимальную частоту яйцекладки, ограничивая ее до одного яйца на цикл, что таким образом меняет размер яиц. При циклах короче 24 часов или длиннее 25 часов яйценоскость понижается почти линейно вплоть до 33-часового цикла. Средняя масса яиц увеличивается почти пропорционально уменьшению яйценоскости. За пределами 28-часового цикла производство яиц неизменно ниже, чем при контрольном 24-часовом цикле.

Улучшение качества скорлупы на 6-10% может иметь место при применении 27 или 28-часового цикла.

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