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Influence of Rearing Photoperiod and Age and Mode of Transfer to Final Photoperiod on Performance in Egg-Type Pullets

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Abstract: Lohmann White pullets were reared on 6, 9 or 12-h photoperiods and abruptly transferred to 14 h at 16 or 18 weeks or in a series of increments from 16 weeks. Body weight at and feed intake to 16 and 18 weeks increased with photoperiod. There were no interactions of rearing photoperiod with photo stimulation age/mode for any performance parameter. Sexual maturity was advanced by rearing on the longer photoperiods and by photostimulating at 16 rather than 18 weeks. Birds reared on 9 or 12 h laid significantly more eggs than 6-h birds, but neither age nor mode of photostimulation significantly affected egg production. Egg numbers were significantly correlated with age at sexual maturity. Mean egg weight was significantly heavier for pullets reared on 9 or 12 h than on 6 h, despite the former's earlier maturity and for birds photostimulated at 18 rather 16 weeks. Mean daily feed in the laying period was not significantly affected by rearing photoperiod or photostimulation age/method and shell quality, though significantly reduced by rearing on longer photoperiods, was minimally affected by the lighting regimens in practical terms. The trend towards rearing egg-type pullets on longer photoperiods was vindicated, irrespective of photostimulation age or method.

Key words: Photoperiod, photostimulation, pullets, rearing, egg production

INTRODUCTION

The photoperiod commonly recommended by primary breeding companies for rearing egg-type pullets has gradually increased from <8 h to 9 or 10 h, primarily to facilitate the achievement of body weight targets in genetically earlier maturing genotypes. In a previous study (Lewis *et al.*, 2007) in which pullets were reared on 6-, 8-, 10- or 12-h photoperiods and transferred to 14 h in a single increment at or series of increments from 18 weeks, feed intake and body weight gain during the prepubertal period were positively correlated with photoperiod. Subsequently, birds reared on the longer photoperiods matured earlier, laid more eggs, had heavier mean egg weights (despite their earlier maturity) and produced stronger shells than birds reared on shorter photoperiods. In the Lewis *et al.* (2007) study, pullets reared on 6 or 8 h matured significantly later than pullets reared on 10 or 12 h and so prediction of the response to the now commonly recommended 9-h rearing photoperiod could not safely be made by interpolation. Genetic selection for egg numbers has resulted in modern genotypes of egg-laying pullet maturing earlier and, as a consequence, having a reduced response to photostimulation at 18 weeks than their ancestors (Lewis *et al.*, 2002) and so, invariably, commercial egg producers now photostimulate pullets before 18 weeks. This study was conducted to assess the influence of photoperiod during the rearing period, including a 9-h photoperiod, on the performance of pullets photostimulated abruptly at or incrementally from the earlier age of 16 weeks.

MATERIALS AND METHODS

Three hundred and thirty six Lohmann White pullets were sourced from a commercial hatchery in Ontario at 1 d of age and placed, 6 birds/cage (60cm x 50 cm), in each of six light-proof rooms (336 birds x 6 rooms = 2016 birds). Illumination was provided by three rows of un-shaded incandescent lamps (General Electric 100W pearl) located at a minimum distance of 145cm from the feed trough. Illuminance was controlled by voltage reduction equipment to achieve a mean intensity at the feed trough of 63±1.4 lux for the first 7 d, 37±0.4 lux between 8 and 14 d and 25±0.3 lux thereafter. All birds received continuous light for the first day and then a 6-, 9- or 12-h photoperiod from day 2 (2 rooms per treatment) until either 16 or 18 weeks of age. At 16 weeks, 32 birds were randomly selected (but excluding obvious culls) from one rearing room for each lighting treatment (Rooms 1, 3 and 5) and transferred to single-bird cages arranged in eight 4-cage plots on two tiers in each of two laying rooms (3 rearing rooms x 2 laying rooms x 4 plots x 4 birds x 2 tiers = 192 birds) and to a 14-h photoperiod (abrupt change at 16 weeks treatment). The photoperiod in the other three rearing rooms (Rooms 2, 4 and 6) was changed to 12 h at 16 weeks (one room was already on 12 h), with a further increase to 13 h at 17 weeks. At 18 weeks, a further 32 birds were randomly selected from each of Rooms 1, 3 and 5 and transferred to each of the two laying rooms and to a 14-h photoperiod (abrupt change at 18 weeks treatment); similarly 32 birds were transferred from Rooms 2, 4 and 6 and to 14 h to achieve a progressive change from a 6-, 9-, or 12-h to a 14-h photoperiod between 16 and 18 weeks of age (stepped increases from 16 weeks treatment). Each laying room contained birds from the three rearing photoperiods (6, 9 or 12 h) x 3 photostimulation methods (abrupt change at 16 or 18 weeks, or stepped increases from 16 weeks) x 8 plots x 4 birds = 288 birds. The remaining birds in the six rearing rooms were used in a separate study. Illumination in each laying house was from 100W incandescent lamps which provided a mean illuminance of 31±0.3 lux at the feed trough on the top tier and 20±0.2 lux on the bottom tier of cages. All birds were given the following crumbled starter, grower or layer diets *ad libitum*: 12.3 MJ/kg ME, 20.0% CP, Ca 1.0%, AvP 0.45% for the initial 8 weeks, 12.3 MJ/kg ME, 17.3% CP, Ca 0.9%, AvP 0.41% from 8 to 16 weeks, 12.0 MJ/kg ME, 19.0% CP, Ca 4.2%, AvP 0.44% from 16 to 42 weeks and 11.9 MJ/kg ME, 17.5% CP, Ca 4.4%, AvP 0.39% from 42 to 66 weeks. Feed intake was recorded to row of cages in each rearing room and to 4-bird plot over a 2-d period in weeks 22, 30, 42, 58 and 66. Within each rearing room, all the birds in 5 specified rearing cages (5 cages x 6 birds x 6 rooms = 180 birds in total) were individually weighed at 8 weeks and again at 12 and 16 or 18 weeks. In the laying rooms, all birds were individually weighed on transfer from the rearing rooms at 16 or 18 weeks and on depletion at 66 weeks. Sexual maturity was defined as the age at which a 4-bird plot first laid 5 eggs in a 48-h period (62.5 eggs/100 bird. d); this stage of maturation was chosen because one of the treatment groups had already reached 50 eggs/100 bird. d lay by the time it was moved to the laying rooms at 18 weeks. Egg numbers were recorded daily to a 6-bird cage in the rearing rooms and per bird in the laying rooms from first egg to depletion at 66 weeks of age. Total egg production to 66 weeks was calculated by summing the mean daily rates of lay (calculated on a proportional hen.day basis) for each 6-bird rearing cage and 4-cage laying plot). Egg weight and shell deformation were determined for the last two eggs laid by each bird in weeks 22, 30, 42, 58 and 66. Shell deformation was measured using dedicated equipment to apply a 500-g weight at two diametrically opposite points on the shell equator. The animals were maintained according to guidelines established by the Animal Care Committee of the University of Guelph (Animal Utilization Protocol # 06R039). Feed intake and body weight data for the rearing period were analyzed using a general linear model ANOVA and all laying-period data using a factorial ANOVA blocked on laying room, from Statistix version 8 (Analytical Software, 2003). Significant differences ($P<0.05$) were identified by a Student's t-test. Meta-analysis were conducted for age at sexual maturity, egg production and mean egg weight on rearing photoperiod and egg production on age at sexual maturity using data from the current and Lewis *et al.* (2007) with differences from these data removed by least squares analysis. Significance of the equality of regression slopes for the effect of rearing photoperiod on rate of sexual maturation for current and Lewis *et al.* (2007) data was tested using the comparison of regression lines model from Statistix version 8 (Analytical Software, 2003). In the manuscript, 'incremental transfers' and 'stepped increases' are synonymous descriptions of the treatment in which the photoperiod was increased to 12 h at 16 weeks, then to 13 h at 17 weeks and finally to 14 h at 18 weeks.

RESULTS

Cumulative feed intake for birds exposed to 6, 9 or 12 h of light was significantly different to 8, 16 and 18 weeks and, at each age, increased with photoperiod (Table 1). Mean body weights were similar for the three photoperiods at 8 weeks, but 12-h birds were significantly heavier than 6- and 9-h groups at 12 weeks and all three groups were significantly different from each other at 16 and 18 weeks with weight increasing proportionately with photoperiod (Table 1). There were no significant interactions between rearing photoperiod and photostimulation age/mode for any of the performance traits and so data were analyzed with the main treatments as variables. Rearing photoperiod significantly affected rate of sexual maturation, with longer photoperiods inducing earlier maturity (Table 2). Pullets abruptly transferred to 14 h at 16 weeks matured significantly earlier than birds that had been photostimulated at 18 weeks, but not differently from birds given stepped increases in photoperiod from 16 weeks. Photostimulation age/mode did not significantly affect egg production, but pullets reared on 9- and 12-h photoperiods laid significantly more eggs than birds reared on 6 h (Table 2), but persistency of lay as indicated by rate of lay between 62 and 66 weeks of age was not significantly affected by rearing photoperiod or photostimulation age/mode. Birds given an abrupt increase in photoperiod at 16 weeks had a lower mean egg weight than those abruptly photostimulated at 18 weeks, but neither was significantly different from birds given the stepped increases from 16 weeks (Table 2). Birds reared on 6 h had a significantly smaller mean egg weight than birds reared on 9 or 12 h. Photostimulation age/mode had no significant effect on shell deformation, but rearing on 12-h photoperiods significantly reduced shell strength (higher deformation) relative to 6 and 9-h photoperiods. Neither rearing photoperiod nor photostimulation age/mode significantly affected mean daily feed intake (Table 2). Pullets reared on 12-h photoperiods had significantly larger body weights at 66 weeks than pullets reared on either 6 or 9 h, but neither age nor mode of photostimulation had a significant effect (Table 1). The similarity of the mean body weights at end of lay for birds reared on 6 and 9 h was a consequence a 74-g significantly larger body weight gain in the laying period for the 6-h birds compensating for the 9-h group's higher mean body weight on transfer to the laying rooms at 16 and 18 weeks. Rearing period had no significant effect on mortality during the laying period, but there was a strong tendency (P<0.10) for the birds photostimulated at 18 weeks (7.3%) to have higher losses than birds transferred abruptly to 14 h at 16 weeks (2.7%), with birds given stepped increases from 16 weeks intermediate at 4.2%.

DISCUSSION

The positive correlation of cumulative feed intake to 8, 16 and 18 weeks with rearing photoperiod and the lack of a photoperiodic effect on body weight at 8 weeks, but positive effect at 16 and 18 weeks agree with the findings of Lewis *et al.* (2007) for the same genotype and with other genotypes studied by Leeson and Summers (1985) and Lewis *et al.* (1996). The 19-g h^{-1} and 25-g h^{-1} of photoperiod increases in body weight at 16 and 18 weeks respectively in this study for pullets reared on 6, 9 or 12 h are in good agreement (slopes P = 0.815, elevations P = 0.251) with the 19-g h^{-1} of photoperiod slope of 18-week body weights for pullets reared on 6, 8, 10 or 12 h reported by Lewis *et al.* (2007). The positive influence of photoperiod on feed intake but non-significant effect on body weight at 8 weeks may be a consequence of higher energy expenditure by pullets kept on longer photoperiods, because heat production during light is higher than in darkness (Berman and Meltzer, 1978; Lewis *et al.*, 1994a). The lack of a significant interaction between the rearing photoperiod and the age or mode of transfer to the final photoperiod indicates that despite the advance in age at sexual maturation achieved by the 14-d earlier photostimulation, the relative response to rearing photoperiod was similar for all treatments (Fig. 1). Analysis of the data in Fig. 1 showed that the slope of the response in the current study (143.5-1.3 d h^{-1} of photoperiod, r^2 = 0.653, P = 0.008) was not significantly different (P = 0.796) from that for data reported by Lewis *et al.* (2007) (151.1-1.2 d h^{-1} of photoperiod, r^2 = 0.904, P<0.001). These findings show that the more stimulatory effect of a transfer from 6 to 14 h, compared with a transfer from 9 or 12 h (Lewis *et al.*, 2002), does not compensate for the delayed gonadal development that results from of rearing on 6 h rather than 9 or 12 h (the model of Lewis and Morris (2005) estimates advances of 12.7 and 16.3 d in sexual maturity, relative to 6 h, for pullets maintained on 9 and 12 h respectively). There is an approximate 10-d period between the commencement of rapid gonadal development and first egg (Lewis and Morris, 2004) and so any egg laid within 10 d of a transfer to a longer photoperiod is not a consequence of the increment but a spontaneous response to the initial photoperiod; a scenario that partly explains the earlier sexual maturation of the pullets reared on 9 or 12 h in the current and previous (Lewis *et al.*, 2007) studies. Figures 2, 3 and 4 show that rate of lay within 10 d of photostimulation at 16 weeks was < 1% for pullets reared on 6 h, but 14 and 45% respectively for 9 and 12-h birds transferred abruptly and 8 and 31% for birds given stepped increases. Following the 18-week transfer to 14 h, the rates of lay on day 136 (i.e., 10 d after the birds had been given an increase in photoperiod) for the 6-, 9- and 12-h groups were 25, 78 and 78% respective. These rates of lay show that the birds had started the final stages of sexual development before they were given the increment in photoperiod and

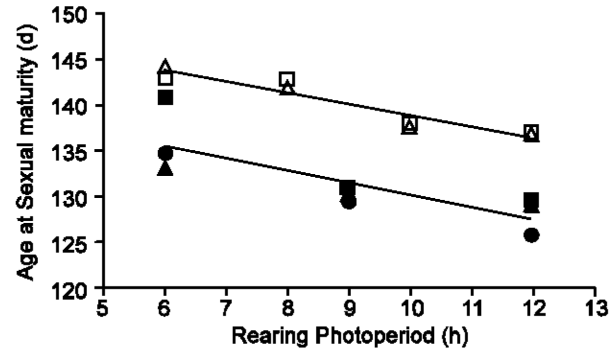

Fig. 1: Regression of age at sexual maturity on rearing photoperiod for Lohmann White pullets transferred abruptly to 14 h at 16 (●) or 18 weeks (■), or incrementally to 14 h between 16 and 18 weeks (▲) in the current study, and transferred abruptly to 14 h at 18 weeks (□) or incrementally to 14 h between 18 and 21 weeks (△) from Lewis *et al.* (2007).

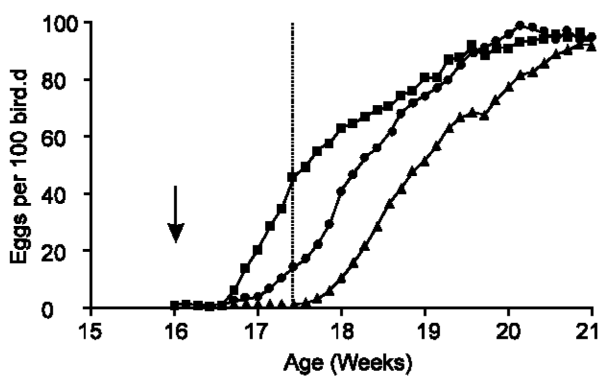

Fig. 2: Daily egg production for Lohmann White pullets reared on a 6- (▲), 9- (●) or 12-h (■) photoperiods and transferred abruptly to 14 h at 16 weeks. The arrow shows photostimulation and the broken vertical line the point of no return before which sexual maturation will have occurred spontaneously

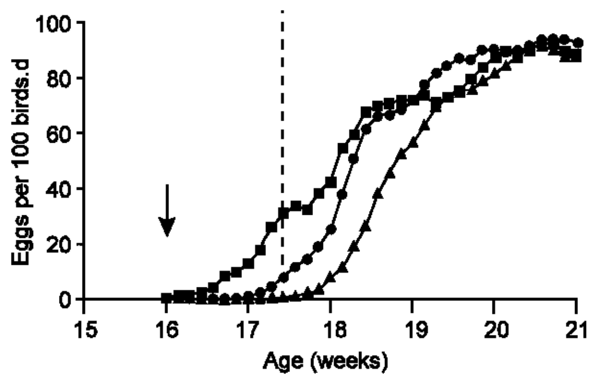

Fig. 3: Daily egg production for Lohmann White pullets reared on a 6- (▲), 9- (●) or 12-h (■) photoperiods and transferred incrementally to 14 h between 16 weeks and 18 weeks. The arrow shows photostimulation and the broken vertical line the point of no return before which sexual maturation will have occurred spontaneously.

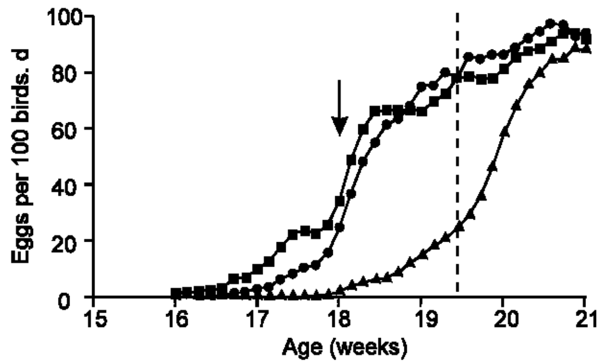

Fig. 4: Daily egg production for Lohmann White pullets reared on a 6- (▲), 9- (●) or 12-h (■) photoperiods and transferred abruptly to 14 h at 18 weeks. The arrow shows photostimulation and the broken vertical line the point of no return before which sexual maturation will have occurred spontaneously.

demonstrate the need to photostimulate pullets before they are 16 weeks of age, at least for the Lohmann White genotype, if complete control of sexual maturation is to be achieved and that later photostimulation will only serve to increase feed intake. Data from this study and that reported by Lewis *et al.* (2007) in Fig. 5 suggest that egg numbers during the laying period are dependent upon rearing photoperiod and increase by about 1 egg for each 1-h longer photoperiod. The regression slopes for the two studies (current study: 303.7+0.93 h^{-1} of photoperiod, r^2 = 0.598, P = 0.015; Lewis *et al.* (2007) study: 319.6+1.14 h^{-1} of photoperiod, r^2 = 0.686, P = 0.011), irrespective of photostimulation age or method,

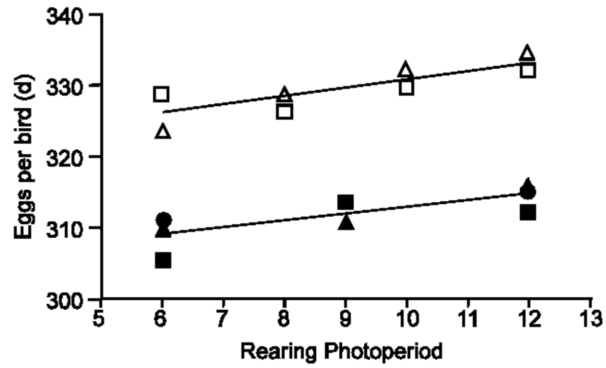

Fig. 5: Regression of egg production to 66 weeks on rearing photoperiod for Lohmann White pullets transferred abruptly to 14 h at 16 (●) or 18 weeks (■), or incrementally to 14 h between 16 and 18 weeks (▲) in the current study, and to 70 weeks for pullets transferred abruptly to 14 h at 18 weeks (□) or incrementally to 14 h between 18 and 21 weeks (△) from Lewis *et al.* (2007).

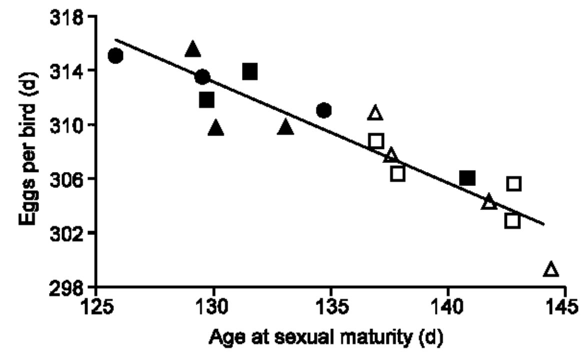

Fig. 6: Regression of egg production (adjusted to 66 weeks by least squares) on age at sexual maturity for Lohmann White pullets transferred abruptly to 14 h at 16 (●) or 18 weeks (■), or incrementally to 14 h between 16 and 18 weeks (▲) in the current study, and transferred abruptly to 14 h at 18 weeks (□) or incrementally to 14 h between 18 and 21 weeks (△) from Lewis *et al.* (2007).

were not significantly different (P = 0.637). It is likely, however, that the true relationship is neither with rearing photoperiod nor photostimulation age but with the age at sexual maturation induced by the lighting regimen. A meta-analysis of data from the current study and Lewis *et al.* (2007), with differences removed by least squares, shows that egg numbers to 66 weeks are reduced by about 7 eggs for each 10-d delay in maturity (409.9-0.74 d^{-1} at sexual maturity, r^2 = 0.976, P<0.001). The data in Fig. 6 and a test for equality of regression slopes also show that the correlation is minimally affected by age at

Table 1: Feed intake to 8 and 16 weeks, and mean body weight at 8, 12, 16, 18, and 66 weeks for Lohmann White pullets reared on 6-, 9-, or 12-h photoperiods and given an abrupt transfer to 14 h from 16 or 18 weeks, or incrementally transferred to 14 h between 16 and 18 weeks

		Rearing photoperiod		
		6 h	9 h	12 h
Feed intake to 8 weeks (kg)		1.87^{c}	1.99^{b}	2.02^{a}
		P < 0.001,	Pooled SED = 0.010,	Res df = 21
Feed intake to 16 weeks (kg)		4.49^{c}	4.63^{b}	4.90^{a}
		P < 0.001,	Pooled SED = 0.033,	Res df = 21
Feed intake to 18 weeks (kg)		5.56^{c}	5.83^{b}	6.19^{a}
		P < 0.001,	Pooled SED = 0.116,	Res df = 21
Mean body weight at 8 weeks (g)		747	750	753
		P = 0.343,	Pooled SED = 4.4,	Res df = 717
Mean body weight at 12 weeks (g)		1058^{b}	1062^{b}	1091^{a}
		P < 0.001,	Pooled SED = 6.2,	Res df = 357
Abrupt change to14 h at 16 weeks		1258^{c}	1301^{b}	1371^{a}
Mean body weight at 16 weeks (g)		P < 0.001,	Pooled SED = 19.0,	Res df = 188
Abrupt change to14 h at 18 weeks		1333^{c}	1443^{b}	1485^{a}
Mean body weight at 18 weeks (g)		P < 0.001,	Pooled SED = 20.6,	Res df = 188
Stepped change to14 h from 16 weeks [1]		1390^{c}	1434^{b}	1477^{a}
Mean body weight at 18 weeks (g)		P < 0.001,	Pooled SED = 19.0,	Res df = 188
Mean body weight at 66 weeks (g)	Mean			
Abrupt at 16 weeks	1852	1834	1807	1914
Abrupt at 18 weeks	1819	1815	1806	1836
Stepped change from 16 weeks [z]	1823	1807	1835	1827
Mean		1819^{b}	1815^{b}	1860^{a}
Rearing treatments P = 0.058, Laying treatments P = 0.207, Pooled SED = 34.2, Res df = 543				

^{a,b,c} within rows, means without a common superscript are significantly different at P<0.05,
[1]increased to 12 h at 16 weeks, to 13 h at 17 weeks, and to 14 h at 18 weeks.

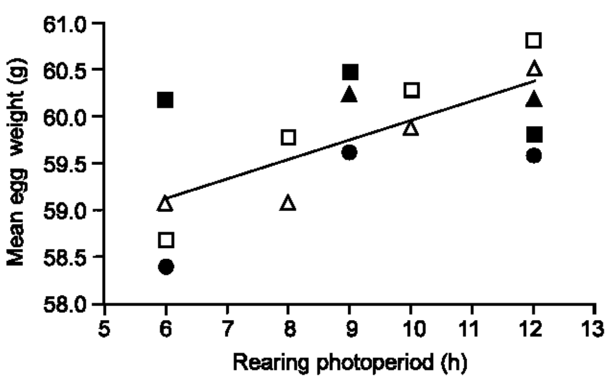

Fig. 7: Regression of mean egg weight to 66 weeks on rearing photoperiod for Lohmann White pullets transferred abruptly to 14 h at 16 (●) or 18 weeks (■), or incrementally to 14 h between 16 and 18 weeks (▲) in the current study, and to 70 weeks for pullets transferred abruptly to 14 h at 18 weeks (□) or incrementally to 14 h between 18 and 21 weeks (△) from Lewis *et al.* (2007).

or mode of photostimulation and, for this genotype at least, consistent between studies. Mean egg weight is usually positively correlated with age at sexual maturity when gonadal development is modified by lighting (Shanawany, 1983; Lewis *et al.*, 1997) and so it is surprising that the birds reared on 6-h day lengths, which matured about 7 d later than birds reared on 9 or 12 h, produced significantly smaller eggs (Table 2); the data in Fig. 7 show that this scenario was also observed by Lewis *et al.* (2007). The regression, with differences between trials removed by least squared analysis, was described by the equation: $57.9+0.21\ h^{-1}$ of photoperiod (r^2 = 0.511, P = 0.001). A meta analysis of mean egg weight on age at sexual maturity, with differences between the two studies removed by least squares, showed a decrease of 0.13 g d^{-1} delay in maturity (r^2 = 0.919, P<0.001). However, birds in the studies by Shanawany (1983) and Lewis *et al.* (1997) had been reared on a single photoperiod and therefore had similar body weights for age. The consequence of this situation was that later maturating pullets had heavier body weights at first egg and, because Lewis *et al.* (1994b) had concluded that it was body weight and not age at first egg that determined egg weight, produced heavier eggs. In the current study and that of Lewis *et al.* (2007), the birds reared on shorter photoperiods had smaller body weights at photostimulation and, as a result, laid smaller eggs, despite being later maturing.

Although photoperiod during the laying period has been reported to significantly affect shell strength characteristics (Lewis *et al.*, 1994c), there are minimal data published for the effect of rearing photoperiod on shell strength. Lewis *et al.* (2007) reported that shell strength, as measured by deformation, had a positive linear relationship with photoperiod for birds reared on

Table 2: Age at sexual maturity, egg numbers, mean egg weight, mean shell deformation and mean feed intake to 66 weeks of age for Lohmann White pullets reared on 6-, 9-, or 12-h photoperiods and given an abrupt transfer to 14 h from 16 or 18 weeks, or incrementally transferred to 14-h between 16 and 18 weeks

Age and mode of transfer to 14-h photoperiod	Rearing photoperiod 6 h	9 h	12 h	Transfer mean
Age at sexual maturity (d) [1]				
Abrupt at 16 weeks	134.7	129.5	125.8	130.0^{b}
Abrupt at 18 weeks	140.8	131.0	129.7	133.8^{a}
Stepped from 16 weeks [x]	133.1	130.1	129.1	130.8^{b}
Rearing mean	136.2^{a}	130.2^{b}	128.2^{c}	
Rearing treatments P <0.001, Laying treatments *P* <0.001, Pooled SED = 0.72				
Eggs to 66 weeks (n) [2]				
Abrupt at 16 weeks	311.2	313.7	315.3	313.4
Abrupt at 18 weeks	305.7	313.8	312.4	310.6
Stepped from 16 weeks [3]	309.9	310.8	315.8	312.2
Rearing mean	309.0^{b}	312.8^{a}	314.5^{a}	
Rearing treatments P = 0.003, Laying treatments P = 0.225, Pooled SED = 1.62				
Mean Egg weight (g)				
Abrupt at 16 weeks	58.5	59.7	59.8	59.3^{b}
Abrupt at 18 weeks	60.2	60.5	59.9	60.2^{a}
Stepped from 16 weeks [3]	58.7	60.3	60.3	59.7^{ab}
Rearing mean	59.1^{b}	60.1^{a}	60.0^{a}	
Rearing treatments P <0.05, Laying treatments P = 0.059, Pooled SED = 0.34				
Mean deformation (µm)				
Abrupt at 16 weeks	22.6	21.7	22.9	22.4
Abrupt at 18 weeks	22.6	23.0	23.1	22.9
Stepped from 16 weeks [3]	22.6	22.3	23.3	22.7
Rearing mean	22.6^{b}	22.3^{b}	23.1^{a}	
Rearing treatments P <0.05, Laying treatments P = 0.244, Pooled SED = 0.28				
Mean feed intake (g/d)				
Abrupt at 16 weeks	97.8	96.4	99.1	97.7
Abrupt at 18 weeks	97.0	99.2	98.0	98.0
Stepped from 16 weeks [3]	98.8	95.9	99.8	98.1
Rearing mean	97.8	97.1	98.9	
Rearing treatments P = 0.178, Laying treatments P = 0.907, Pooled SED = 0.97				

^{a,b,c} means without a common superscript are significantly different at P<0.05. Res df = 134 for all traits,
[1]Age at sexual maturity = day that a 4-bird plot first laid 5 eggs in 2 d = 62.5%, [2]sum total of daily rates of lay calculated on a hen.day basis, [3]increased to 12 h at 16 weeks, to 13 h at 17 weeks, and to 14 h at 18 weeks.

6-, 8-, 10- or 12 h photoperiods, despite an ANOVA having shown that 8, 10 and 12 h treatments were not significantly different from each other. The ranges of mean deformations for the various treatment groups in this study and that of Lewis *et al*. (2007) were relatively narrow ($\leq$ 1 µm), which, together with the conclusion of Wells (1968) that shell deformation is poorly correlated with the percentage of cracked eggs reported by an egg-packing station, suggest that rearing photoperiod has minimal influence on the proportion of eggs downgraded commercially. The non-significant effect of lighting regimen on mean daily feed intake and the heavier body weight at 66 weeks for birds reared on 12 h, relative to those reared on 6 or 9 h and irrespective of photostimulation age and method, agree with the findings of Lewis *et al*. (2007). In general these findings and those from our earlier study (Lewis *et al*., 2007) support the current practice of rearing egg-type pullets on day lengths longer than the previous norm of 8 h, though the egg production, egg weight and quality data in Table 2 indicates that there is probably little point going beyond 9 h. The current study also demonstrates the need to transfer to a final photoperiod before 16 weeks when pullets are reared on longer day lengths in order to avoid spontaneous gonadal development and thus maintain control over the timing of sexual maturation. It should be noted, however, that Lewis (2001) cautioned against photostimulating before 14 weeks because of poor persistency of lay and some primary breeder companies have recommended a minimum body weight at photostimulation, for example >1250g (Hubbard, 2000).

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