Relationship Between Shell Color and Incidence of Speckles in Brown Egg Lines

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Introduction

In nature, egg pigmentation serves as camouflage, and it may have a role in thermoregulation (Solomon, 1997). Most wild bird species show some pattern of speckling. Response to selection for shell color in brown-egg layer lines has been successful in providing darker and uniformly colored eggs; however, a side problem for marketing purposes is an increased incidence of spots or speckles. It is desirable to apply selection to produce darker but spot-free eggs.

Objective

The objectives of the research herein were to estimate variance components and parameters for the incidence of speckles and to determine its genetic relationship with shell color in four established brown-egg lines.

Data

Four established Hy-Line brown-egg layer lines used. Shell color (CO) measured by Minolta® Chroma Meter CR400 (Minolta Inc.), and incidence of speckles (SP), measured in an increasing scale from 0 (clean) to 5 (intense spotting) by subjective scoring (Picture 1).
Three generations of data and full pedigree information were used in the analysis (Table 1). Traits measured during early (25 wk of age) and late (40 wk of age) laying evaluations.

Statistical Analysis

A set of linear animal models were implemented to jointly evaluate the co-inheritance of SP and CO using average information REML in the family of BLUPF90 programs (Misztal et al., 2002).
Models included: (1) Repeatability model to estimate the relative importance of additive genetic vs. animal permanent environmental effects, and to estimate repeatability. (2) Average-record models to explore a simplified implementation aiming to reduce number of records. (3) Within the former implementations (1 and 2), early and late evaluation were initially considered as being different traits to estimate genetic and residual correlations between the two evaluation periods.
All models included the fixed effect of hatch-generation. For (1) and (2) separated analyses were carried out for early (CO_E, SP_E) and late (CO_L, SP_L) evaluation. Here, only the full four-trait model (CO_E, SP_E, CO_L, SP_L) with averaged records, and the combined repeatability model, including a fixed factor to account for the period of evaluation, are presented due to length restrictions.

Table 1

Line	1	2	3	4
Animals with records	10,721	15,894	17,281	9,449
Total records	53,481	87,503	92,123	50,764
Sires	209	240	206	220
Dams	1,454	1,635	1,268	1,032
Color average (SD)	86.28 (7.05)	84.02 (7.02)	83.20 (6.93)	88.49 (7.33)
Speckles average (SD)	0.28 (0.68)	0.36 (0.85)	0.51 (1.10)	0.71 (1.08)

Results & Dicussion

Results for the full four-trait model for the averaged records and the largest population (Line 3) are summarized in Table 2. Genetic correlation between early and late SP scores was large and similar to CO. That favors the use of pooled data, to implement a simpler repeatability model, for breeding value prediction to use for practical selection purposes.
The genetic correlations between CO and SP score were moderate and positive in both evaluation periods but were slightly lower for early than late evaluation. The corresponding residual correlations tended to be low. This indicates that intense selection for increased shell color may have negative long term effect on the incidence of speckles.

Table 2

	σ^2_a or $\sigma_{a1,a2}$		h^2 or $r_{a1,a2}$	σ^2_e or $\sigma_{e1,e2}$		e^2 or $r_{e1,e2}$
	Mean	se		Mean	se	
CO_E	23.7	0.77	0.67	11.6	0.47	0.33
CO_L	27.6	1.29	0.66	14.3	0.05	0.34
SP_E	0.16	0.01	0.30	0.36	0.01	0.70
SP_L	0.38	0.02	0.50	0.38	0.00	0.50
CO_E,CO_L	24.4	0.88	0.95	6.36	0.03	0.49
CO_E,SP_E	0.69	0.56	0.36	0.18	0.06	0.09
CO_E,SP_L	1.38	0.11	0.46	0.27	0.72	0.13
CO_L,SP_E	0.56	0.07	0.27	0.19	0.08	0.09
CO_L,SP_L	1.28	0.13	0.40	0.38	0.01	0.16
SP_E,SP_L	0.23	0.01	0.94	0.12	0.02	0.33

σ^2_a = additive genetic variance; σ^2_e = residual variance; $\sigma_{a1,a2}$ = genetic covariance; $\sigma_{e1,e2}$ = residual covariance; h^2 = heritability; $r_{a1,a2}$ = genetic correlation; e^2 = residual variance; $r_{e1,e2}$ = residual correlation.

Results from the combined repeatability model for all lines are shown in Table 3. Part of the variance associated to animal additive effects in the average-record analysis corresponded to permanent environmental variance for both traits.

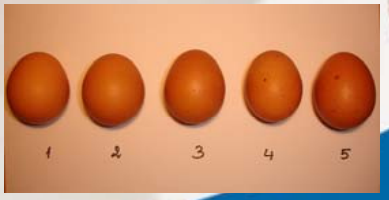
The heritability estimates for SP varied with line, and tended to be low to moderate; however, these values are acceptable, considering the skewed distribution of the trait. Selection against speckles could be implemented in situations with large SP incidence; however, the selection response would be slow. On the other hand, repeatability of SP scoring showed moderate values, indicating that there would be a considerable advantage of using repeated records if a selection strategy to control SP is to be applied.

Table 3

		σ^2_a or $\sigma_{a1,a2}$		h^2 or	σ^2_e or $\sigma_{e1,e2}$		e^2 or	σ^2_c		re
Line	Traits	Mean	se	$r_{a1,a2}$	Mean	se	$r_{e1,e2}$	Mean	se	
1	CO	18.7	0.85	0.39	16.0	0.01	0.33	13.1	0.50	0.67
	SP	0.07	0.01	0.15	0.31	0.00	0.67	0.08	0.003	0.33
	CO-SP	0.61	0.03	0.54	0.001	0.001	0.00	-	-	-
2	CO	27.2	0.88	0.52	16.1	0.01	0.31	8.9	0.46	0.69
	SP	0.12	0.01	0.18	0.41	0.00	0.64	0.11	0.003	0.36
	CO-SP	0.69	0.03	0.39	0.12	0.002	0.05	-	-	-
3	CO	9.4	0.38	0.21	13.5	0.05	0.30	22.3	0.72	0.70
	SP	0.23	0.01	0.22	0.64	0.002	0.61	0.18	0.01	0.39
	CO-SP	0.55	0.02	0.37	0.05	0.01	0.02	-	-	-
4	CO	16.8	0.78	0.32	28.3	0.02	0.53	7.9	0.44	0.47
	SP	0.24	0.02	0.22	0.63	0.00	0.58	0.24	0.01	0.42
	CO-SP	0.70	0.04	0.35	0.05	0.003	0.01	-	-	-

σ^2_a = additive genetic variance; σ^2_e = residual variance; $\sigma_{a1,a2}$ = genetic covariance; $\sigma_{e1,e2}$ = residual covariance; h^2 = heritability; $r_{a1,a2}$ = genetic correlation; e^2 = residual variance; $r_{e1,e2}$ = residual correlation; σ^2_c = permanent environmental variance; re = repeatability

Extreme selection in favor of intense color may increase the incidence of SP in the long term; however, the low frequency of extreme SP scores indicate that the current selection intensity for CO is not creating a problem with incidence of SP in the four lines under consideration in the present study. Selection for increased CO and against SP has been successful in producing dark uniform brown eggs relatively free of speckles.



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