GENETIC PARAMETERS AND THE IMPROVEMENT FOR EGG SHELL STRENGTH IN DOMESTIC FOWL

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SUMMARY

Selection has been conducted in White Leghorn population for increased (weak line) or decreased (strong line) non-destructive deformation. The same environment conditions were given to the both lines through the all generations. In generation 10, non-destructive deformation was reduced to 51.9 micro m/kg in strong line and increased to 100.6 micro m/kg in weak line. Breaking strength in generation 10 was 3.75 kg in the strong line and 2.17 kg in the weak line. Selection for non-destructive deformation was effective in improving egg shell strength and the strong and weak lines were separated genetically. The degree of selection response was not equal in the two directions. Non-destructive deformation had a heritability value of 0.33 and genetic correlations were -0.77, -0.89 and -0.94 with breaking strength, shell thickness and percentage shell in the weak line, respectively. Genetic correlations of shell traits with rate of lay were negative but with egg weight were positive. The selection for the strong shell can increase the egg weight but reduce the rate of lay.

Keywords: Selection, genetic parameter, chicken, deformation, shell strength

INTRODUCTION

Non-destructive deformation (NDD) is one of indicators for egg shell strength (Voisey et al., 1979). A smaller value means stronger egg shell. There is, however, little information concerning the usefulness of non-destructive deformation as a selection criterion for improvement of egg shell strength. We carried out two-way selection for NDD increase (weak line) and decrease (strong line) over ten generations. Effectiveness of selection on NDD was investigated during the selection experiment. Genetic parameters for NDD and the other egg shell traits and production traits were estimated.

MATERIALS AND METHODS

In total of 3352 females for the strong line and 3268 females for the weak line were used for the data analysis. Two hundred and forty one White Leghorn were used as the base population for both the weak line and the strong line for NDD selection. Each line had 80 males and 320 females in each generation. The same environment conditions were given to the both lines through the all generations. Ten males and eighty females were selected as parents for the next generation. Females were selected on their individual records and males were selected on the full-sib mean weighted by $n/(2+(n-1)h^2)$, where n represents the number of full sisters

and h^2 was assumed heritability, 0.3 (Falconer, 1981). Five egg shell traits, NDD, breaking strength, shape index, shell thickness and percentage shell, were measured. The three other production traits, egg weight, sexual maturity and rate of lay, were also observed. Restricted maximum likelihood (REML) was applied to an individual animal model using generation as a fixed effect (Misztal,1993).

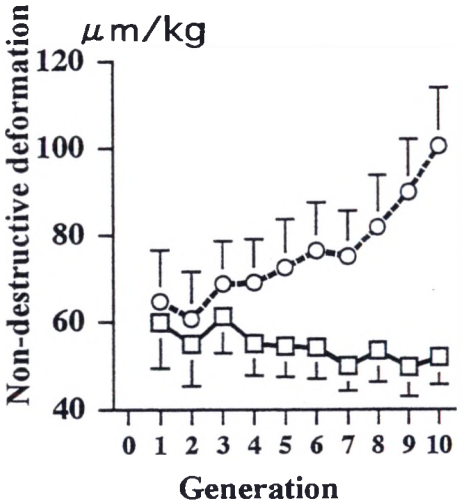

Figure 1. Selection responses for increased (weak line, ○) and decreased (strong line, □) non-destructive deformation. The vertical bars represent standard deviation.

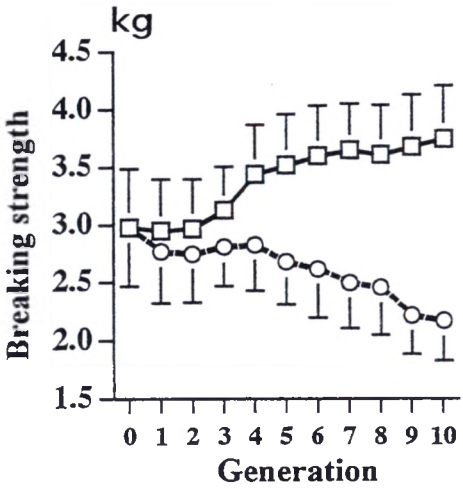

Figure 2. Correlated responses in breaking strength to selection for increased (weak line, ○) and decreased (strong line, □) non-destructive deformation. The vertical bars represent standard deviation.

RESULTS AND DISCUSSION

The difference on NDD between the strong and the weak line tended to increase gradually due to selection. In generation 10, NDD was 51.9 micro m/kg in the strong line and 100.6 micro m/kg in the weak line. Breaking strength in generation 10 was 3.75 kg in the strong line and 2.17 kg in the weak line. Average phenotypic values on NDD and breaking strength across generations are shown Fig. 1 and 2. Selection for NDD was effective in increasing shell strength and the strong and weak lines were genetically separated. The degree of selection response were not equal in the two directions. The deviation of shell strength from the base population was larger in the weak line than that of the strong line. The weak line could have the larger selection response. The White Leghorn had been selected for the strong shell

(small NDD) may be reaching selection limit for the strong shell. Means and standard deviations in both lines are shown Table 1. Some shell traits showed different means between two lines. Shell thickness was 357.3 micro m in the strong line and 257.7 micro m in the weak line. Percentage shell and shell weight were 10.04% and 5.32 g in the strong line and 7.32% and 3.70g in the weak line. This suggests that these shell traits are related to shell strength. Genetic parameters in weak and strong lines are shown Table 2. Genetic correlations of NDD with breaking strength, shell thickness and percentage shell were -0.77, -0.89 and -0.94, respectively. All genetic correlations between rate of lay and the shell traits, break strength, shell thickness, shell weight and percentage shell, were negative. Since stronger shell has a smaller value for NDD, genetic correlation with rate of lay was positive. That means selection for the stronger shell causes a reduction in the rate of lay. Naito et al. (1989) reported that selection for increased rate of lay reduced egg shell strength. Furthermore, egg weight had positive genetic correlations with shell traits and negative correlation with rate of lay. The results indicate that the selection for strong shell increases the egg weight but reduce the rate of lay. The heritabilities of these shell traits were 0.36 for break strength, 0.40 for shell thickness, 0.38 for percentage shell. NDD is a better measure of shell strength than other shell traits, because NDD can be observed without destruction and has intermediate heritability of 0.33.

Table 1. Means and standard deviations of egg shell quality and egg productivity in weak and strong lines

Trait	Strong line		Weak line	
	Means	S.D.	Means	S.D.
Non-destructive Deformation (micro m/kg)	51.9	6.24	100.6	13.4
Breaking Strength (kg)	3.75	0.46	2.17	0.34
Egg weight(g)	53.06	3.22	50.50	3.32
Shell Thickness(micro m)	357.3	19.1	257.7	17.1
Shell weight (g)	5.32	0.37	3.70	0.32
Percentage Shell (%)	10.04	0.55	7.32	0.48
Sexual Maturity(days old)	151.6	13.0	132.5	7.0
Rate of lay %)	73.0	9.6	86.2	7.8

Table 2. Estimates of genetic parameters in weak and strong lines

	EW	BRK	ST	SW	PS	NDD	SM	RL
Egg weigh	**0.61**	0.06	0.29	0.74	-0.20	0.02	0.11	-0.17
(EW)	**0.62**	0.35	0.27	0.75	-0.11	-0.06	0.24	-0.21
Breaking	0.09	**0.29**	0.72	0.56	0.74	-0.78	0.36	-0.34
Strength(BRK)	0.02	**0.35**	0.76	0.74	0.68	-0.77	0.27	-0.31
Shell	0.13	0.64	**0.37**	0.84	0.85	-0.81	0.26	-0.32
Thickness(ST)	0.21	0.69	**0.40**	0.82	0.89	-0.89	0.19	-0.22
Shell weight(SW)	0.55	0.58	0.80	**0.49**	0.51	-0.52	0.26	-0.30
	0.57	0.62	0.84	**0.48**	0.58	-0.68	0.29	-0.28
Percentage	-0.15	0.61	0.85	0.71	**0.39**	-0.92	0.23	-0.22
Shell(PS)	-0.06	0.74	0.88	0.78	**0.38**	-0.94	0.13	-0.16
Non-destructive	0.06	-0.69	-0.79	-0.60	-0.85	**0.24**	-0.19	0.48
Deformation(NDD)	-0.07	-0.70	-0.79	-0.72	-0.84	**0.33**	-0.16	0.19
Sexual	0.15	0.10	0.05	0.10	-0.02	-0.07	**0.47**	-0.12
Maturity(SM)	0.07	0.01	0.03	0.04	-0.01	0.02	**0.38**	0.09
Rate of lay(RL)	-0.13	-0.03	-0.02	-0.07	0.01	0.09	-0.11	**0.26**
	-0.07	-0.09	-0.06	-0.07	-0.04	0.00	-0.13	**0.18**

Heritabilities are bold and on the diagonal, genetic correlations are above the diagonal, and phenotypic correlations are below the diagonal.
The upper part is a strong line and the lower part is a weak line.

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