GENETIC TRENDS OF PRODUCTION AND REPRODUCTION TRAITS IN WHITE LEGHORN LINES SELECTED FOR PRODUCTION TRAITS

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SUMMARY
Data from a selection experiment conducted with White Leghorn lines were used as the basis for an evaluation of responses to selection for increased production and correlated responses of reproduction traits. Data on egg number (EN), egg weight (EW), percent fertile eggs (PF) and percent hatched of fertile eggs (PHF) were collected from the two lines as a part of a ten-generation experiment in which increased egg number (Ln1) and egg weight (Ln2) were selected for. Genetic trends for direct and correlated responses were calculated for each line. Direct selection for increased egg number in Ln1 and egg weight in Ln2 resulted in substantial genetic gain over generations. Moreover, in the line selected for EN there were consistent positive genetic trends in terms of the PHF and along with egg number. Selection for increased egg weight, however, negatively affected PF and PHF over generations.
Keywords: selection, fertility, hatchability, breeding value, genetic trend.

INTRODUCTION
To increase the genetic capacity of animals of economic importance, breeding programmes based on selection are used. The egg production efficiency of chickens has improved remarkably in the last few decades. However, changes in flock management may have also contributed to this increase. One way to evaluate breeding schemes already being applied is to analyse the phenotypic trend observed and separate it into its genetic and residual components. Selection based on the best linear unbiased prediction (BLUP) of breeding values obtained by Henderson's mixed model is used in animal breeding since the correlation between the predicted and true breeding values is optimised. An added advantage of using BLUP is that responses to selection can be determined without having to use a control line. Sorensen and Kennedy (1984) stated that in order to accurately predict breeding values, it is necessary to have good knowledge of genetic parameters such as heritabilities and genetic correlations for the traits considered. The aims of this study were i) to estimate (co)variance components of egg production and reproductive fitness traits, and ii) to estimate the genetic trends for production and reproduction traits in two White Leghorn lines which were selected for production traits.

MATERIALS AND METHODS

The data used in this study were obtained from two White Leghorn lines (Liljedahl et al. 1979; Sewalem et al. 1997). One line selected for egg number (Ln1) and one line selected for egg weight (Ln2) were derived from the same base population. In each line the data consisted of egg number (EN) and egg weight (EW) for ten generations of selection. In addition, for the selected parents, records on percent fertile eggs (PF) and percent hatched of fertile eggs (PHF) were available. A total of 5878 and 5013 records on production and 1315 and 1482 records on reproductive fitness traits for Ln1 and Ln2, respectively were included in the analysis. A multivariate animal model containing the combination of generation and house as a fixed effect and animal and residual as random effects were used to analyse the data. Estimations of (co)variance components were carried out using the DMU software package, with an EM-algorithm (Jensen et al. 1996). The package estimated (co)variances of random effects by using the restricted maximum likelihood (REML) method. Each line was analysed separately. Parameters obtained from REML estimates were used to estimate the breeding values of each animal. The genetic trends were calculated by averaging the estimated breeding values (EBV) of individuals for which records were available in each generation.

RESULTS AND DISCUSSION

Table 1 presents estimates of heritability, genetic and phenotypic correlations between production and reproductive traits in the egg number (Ln1) and egg weight (Ln2) lines.

Table 1. Estimates of heritabilities (diagonal), genetic correlations (above diagonal) and phenotypic correlations (below diagonal) for the traits studied in the two lines

	EN	EW	PF	PHF
Ln1: EN	**0.21 ± 0.02**	-0.25 ± 0.05	-0.06 ± 0.14	0.46 ± 0.12
EW	-0.08	**0.70 ± 0.01**	-0.04 ± 0.09	-0.26 ± 0.10
PF	0.10	0.02	**0.14 ± 0.03**	0.74 ± 0.17
PHF	0.12	-0.05	0.14	**0.10 ± 0.03**
Ln2 :EN	**0.34 ± 0.02**	-0.39 ± 0.04	0.22 ± 0.18	-0.34 ± 0.13
EW	-0.14	**0.61 ± 0.02**	-0.43 ± 0.20	-0.36 ± 0.10
PF	0.06	-0.03	**0.05 ± 0.02**	0.50 ± 0.30
PHF	0.004	-0.17	0.05	**0.10 ± 0.03**

The genetic standard deviations for EN, EW, PF and PHF were 8.60, 2.93 g, 6.17% and 4.12%, respectively in Ln1. The corresponding figures in Ln2 were 10.53, 3.29 g, 4.12%, and 5.36%. The heritabilities of EN and EW found in this study were similar to those found in the literature (Kinney, 1969; Liljedahl et al. 1979; Jorjani et al. 1993). PF and PHF had low heritabilities, indicating that the amount of additive genetic variance, in percent of the total variance, was low (Table 1). In both lines the genetic correlation between egg number and egg weight was negative and significant. The phenotypic correlation was also negative but small.

PF showed weak genetic correlations with EN and EW in Ln1 but moderate and negative correlations with EW in Ln2. Percent hatched of fertile eggs showed a moderate, positive genetic correlation with EN in Ln1 and a negative genetic correlation with EW in Ln2.

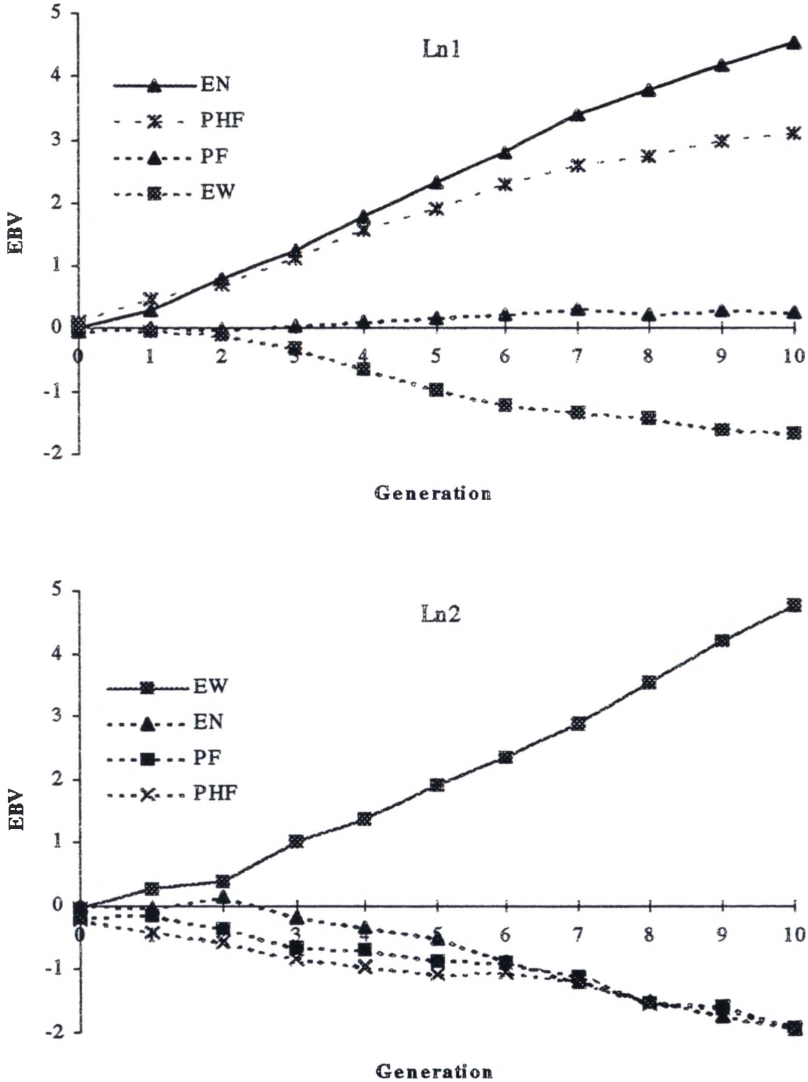

Figure 1. Estimated genetic trends, expressed as genetic standard deviations for egg number (EN), egg weight (EW) percent fertile eggs (PF) and percent hatched of fertile eggs (PHF), for the two lines.

Genetic trends for the direct and correlated responses of the traits, expressed as genetic standard deviations are shown in Figure 1. The genetic trend for EN in Ln1 and for EW in Ln2 increased steadily over generations. The estimated genetic gain for EN in Ln1 and EW in Ln2 was 3.39 eggs and 1.49 g, respectively, per generation. The existence of negative genetic correlation between egg number and egg weight is clearly illustrated by the marked decline (0.47 g) in egg weight as a result of selection for egg number in Ln1 and the pronounced decrease in egg number (2.03 eggs) as a result of selection for egg weight in Ln2. Figure 1 shows that there was a constant positive genetic trend in percent hatched of fertile eggs in Ln1. The degree of correlated genetic gain was 1.35% per generation. The change in PF was small but positive. On the other hand, negative genetic trends were observed for PF and PHF in Ln2.

Since egg weight was negatively and moderately correlated with PF and PHF at the genetic level in Ln2, selection for this trait is likely to depress the fertility and hatchability of the line. Sewalem et al. (1997) reported that PF and PHF were significantly lower in the egg weight line than in the egg number line. In Ln1 the correlation between PHF and egg number was positive and moderate. This might be of significance where natural selection is allowed to influence population structure. Hunton (1971) stated that where different reproductive rates are permissible in a multiplication programme producing parent stock or commercial stocks, the progeny of highly productive birds will be better represented than those of low-productive birds. Highly productive birds will not only produce more eggs, but a greater proportion of these eggs will hatch. Although this could be an advantage to the breeder as far as egg production is concerned, it might cause a shift in population means for other correlated traits like egg size. In conclusion, direct selection for increased EN and EW has resulted a substantial genetic gain over generations. The correlated response of PHF showed a positive genetic trend along with EN in the line selected for egg number. However, a negative trend was observed in the line selected for egg weight, indicating that selection for high egg weight adversely affected fertility and hatchability.

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