EFFECT OF LONG TERM SELECTION ON GENETIC PARAMETERS OF ECONOMIC TRAITS IN WHITE LEGHORN

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Summary

The genetic parameters for various economic traits were estimated in a White Leghorn population selected for part period egg production over 16 generations. In early part of selection, egg number had moderate to high heritability (0.26 to 0.51) while age at sexual maturity, egg weight and body weight at 20 and 40 weeks of age had high heritability (0.54 to 0.83). The sire component heritability for all the traits except 20 week body weight declined in later periods of selection. Sex linked gene effects for egg number and age at sexual maturity were more important in early periods of selection in comparison to the later periods, while maternal effects remained important for 20 week body weight in all the periods. Egg number was negatively correlated with egg weight ($r_{G(S)} = -0.36$), age at sexual maturity ($r_{G(S)} = -0.84$) and 40 week body weight ($r_{G(S)} = -0.84$), while it was positively correlated with 20 week body weight ($r_{G(S)} = 0.34$) in base generation. The genetic association between egg number and 40 week body weight changed not only in magnitude but also in direction in later periods. The genetic correlation of egg number with egg weight as well as with age at sexual maturity also decreased in magnitude in later periods of selection.
(**Key Words** : Genetic Parameters, White Leghorn, Selection)

Introduction

The genetic parameters of a population are required not only for predictions of responses, but also used as a base for the future selection and breeding strategies. Genetic parameters are liable to change in a population under continuous selection (Falconer, 1960). There are number of reports revealing the genetic parameters of various economic traits in White Leghorn population at a specific period or pooled over the whole period of study (Poggenpoel and Erasmus, 1978; Chaudhary et al., 1986; Singh et al., 1986; Chaudhary et al., 1988; Johari et al., 1988; Brah et al., 1991). However, the genetic parameters at different periods of long term selection in a population are lacking in literature except few reports like that of Poggenpoel and Erasmus (1978) and Gowe and Fairfull (1985). This paper presents the genetic parameters in a White Leghorn population during different periods of its long term selection for part period egg production.

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Materials and Methods

A White Leghorn population (IWG) subjected to long term selection for part period egg production (number of eggs upto 280 days of age) was utilized in the present study. The generation 1974-75 was first pedigreed generation, subjected to selection. The criterion of selection was a combined index (Osborne, 1957a,b). There after this strain was under continous selection for egg number. Average number of sire and dam per generation were 43.59 and 172.65. Average number of birds studied was 810.17 per generation. The birds were maintained under uniform managemental conditions over generations as far as possible. The traits recorded were part period egg production - number of eggs laid upto 280 days of age, egg weight - average egg weight of three consecutive eggs at 40 weeks of age in grams, age at sexual maturity - age at first egg in days, 20 and 40 week body weight - body weight of individual bird at 20 and at 40 weeks of age in grams.

As the chicks were obtained in unequal number of hatches in different generation, the data were adjusted for hatch effect taking it as a fixed effect (Model 1, Harvey, 1988). The data for the period under selection were grouped into four periods, each consisting of 4 generations in view to represent the different stages of selection. The periods were: Period Ⅰ - S1-S4, Period Ⅱ - S5-S8, Period Ⅲ - S9-S12 and Period Ⅳ - S13-S16. For estimating the genetic parameters of base generation, 1974-75 generation and 1975-76 generation were pooled due to smaller population size during 1974-75 year. The genetic parameters in each of the period were estimated using the hatch adjusted data from the following model:

$$Y_{ijkl} = \mu + A_i + b_{ij} + c_{ijk} + e_{ijkl}$$

where A_i is fixed generation effect, b_{ij} is random nested effect of sire nested within generation, c_{ijk} is random nested effect of dams nested within generation and sire and e_{ijkl} is random error (Model 5, Harvey, 1988).

Results and Discussion

The heritability estimates for economic traits in the selected strain in different periods of selection are presented in table 1. The moderate to high heritability estimates for egg number, age at sexual maturity, egg weight and body weights at 20th and 40th week of age were observed in base generation. The higher estimates from sire component of variance in comparison to those from dam component suggested the more importance of sex linked genes in the inheritance of most of the traits except egg weight. In general, these estimates were in agreement to the reports of Poggenpoel and Erasmus (1978), Chaudhary et al. (1986), Singh et al. (1986) and Brah et al. (1991).

The heritability estimates for egg number from sire component showed (figure 1) a gradual but consistent decline with the advancement of the selection. The maternal and/or dominance effect were more important in later periods of selection as evident from higher estimates from dam component than those from sire component. These results reflect a probable decline in additive genetic variance over generations, while the genetic variance due to dominance and epistasis deviation remained unexhausted. Poggenpoel and Erasmus (1978) observed a decline in heritability from sire plus dam component from 0.35 in 1953-62 to 0.19 in 1963-69, however no such decline was reported by Craig et al. (1969), Liljedhal and Weyde (1980) and Gowe and Fairfull (1985).

The heritability from sire component declined for egg weight over generations. The sex linked genes seemed to

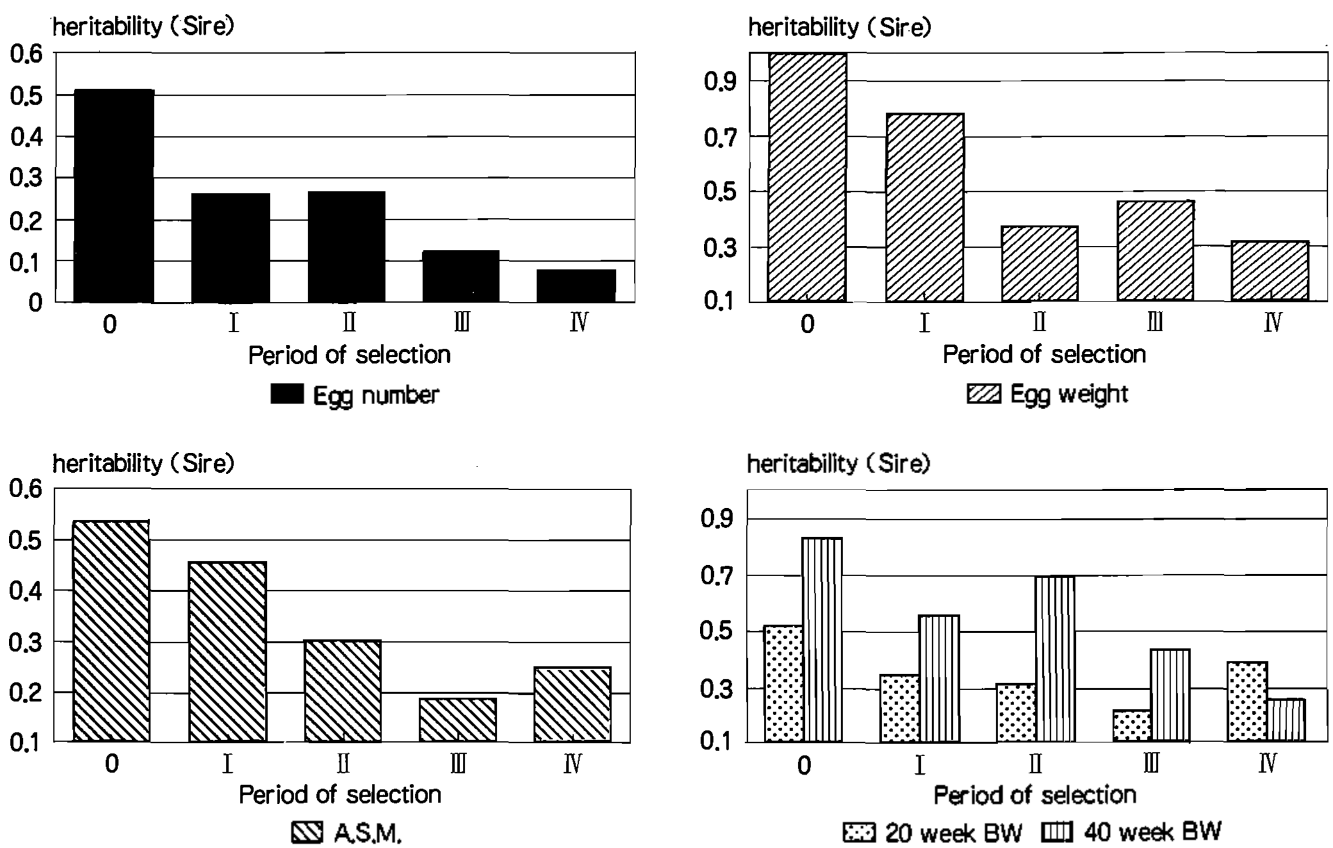

Figure 1. Heritability (Sire) of the selected and unselected traits in WL.

TABLE 1. HERITABILITY ESTIMATES FOR VARIOUS ECONOMIC TRAITS IN DIFFERENT SELECTION PERIODS

Periods	Heritability		
	Sire component	Dam component	Sire+Dam component
	Egg number		
Base Gen.	0.513±0.137	0.204±0.123	0.359±0.068
Period I	0.264±0.057	0.253±0.066	0.259±0.035
Period II	0.266±0.055	0.159±0.061	0.212±0.032
Period III	0.123±0.041	0.411±0.067	0.267±0.034
Period IV	0.079±0.029	0.138±0.046	0.109±0.021
	Egg weight		
Base Gen.	1.019±0.193	0.642±0.134	0.831±0.079
Period I	0.785±0.102	0.470±0.071	0.628±0.046
Period II	0.373±0.065	0.525±0.070	0.449±0.041
Period III	0.464±0.069	0.340±0.066	0.402±0.038
Period IV	0.313±0.049	0.367±0.053	0.340±0.032
	Age at sexual maturity		
Base Gen.	0.537±0.140	0.245±0.124	0.391±0.070
Period I	0.456±0.076	0.310±0.068	0.383±0.040
Period II	0.304±0.058	0.299±0.064	0.301±0.036
Period III	0.190±0.047	0.308±0.065	0.249±0.033
Period IV	0.251±0.044	0.363±0.052	0.307±0.030
	20 week body weight		
Base Gen.	0.526±0.139	0.399±0.129	0.463±0.073
Period I	0.351±0.066	0.566±0.073	0.459±0.043
Period II	0.391±0.060	0.377±0.066	0.348±0.038
Period III	0.218±0.049	0.506±0.069	0.362±0.037
Period IV	0.392±0.056	0.433±0.054	0.412±0.034
	40 week body weight		
Base Gen.	0.830±0.175	0.443±0.130	0.636±0.077
Period I	0.561±0.085	0.601±0.074	0.581±0.045
Period II	0.698±0.091	0.372±0.066	0.535±0.043
Period III	0.434±0.067	0.546±0.070	0.490±0.041
Period IV	0.358±0.053	0.492±0.056	0.425±0.034

be more important in earlier generations, whereas maternal effects gained importance in later periods of selection. For age at sexual maturity, the similar trends were observed. Though the heritability showed marked decline, when estimated from sire component, the maternal gene effects were found to be more important in all the periods of selection except base generation for body weight at 20 weeks of age. For 40 week body weight also, more or less similar trend was observed. The decline in heritability of the unselected traits may be due to indirect changes as a result of selection for egg number to a fixed age. Similarly, the gene effects influencing inheritance of these traits also changed over the periods of selection. The maternal and/or dominance effects influenced these traits to a greater extent in later periods in comparison to the early periods of selection except for 20 week body weight, where the maternal effects remained dominated in all the periods of selection except in base generation.

The estimates of genetic correlation among the economic traits in the selected line in different periods of selection are presented in table 2. In general, egg number had a moderate and negative genetic correlation with egg weight, high and negative association with age at sexual

TABLE 2. GENETIC CORRELATION BETWEEN EGG PRODUCTION AND OTHER ECONOMIC TRAITS IN VARIOUS SELECTION PERIODS

Periods	Genetic correlations		
	Sire component	Dam component	Sire+Dam component
	Egg number × egg weight		
Base Gen.	−0.576±0.139	0.222±0.329	−0.308±0.127
Period I	−0.459±0.110	−0.137±0.171	−0.318±0.086
Period II	−0.437±0.122	−0.381±0.213	−0.401±0.094
Period III	−0.380±0.147	0.326±0.159	0.047±0.092
Period IV	0.046±0.164	−0.061±0.190	0.109±0.021
	Egg number × Age at sexual maturity		
Base Gen.	−0.914±0.173	−0.732±0.932	−0.859±0.207
Period I	−0.822±0.126	−0.942±0.366	−0.872±0.114
Period II	−0.915±0.146	−0.839±0.455	−0.876±0.137
Period III	−0.830±0.271	−0.903±0.296	−0.869±0.135
Period IV	−0.410±0.194	−0.922±0.309	−0.792±0.217
	Egg number × 20 week body weight		
Base Gen.	0.400±0.157	0.551±0.294	0.448±0.117
Period I	0.441±0.116	0.243±0.146	0.328±0.085
Period II	0.272±0.124	0.547±0.182	0.392±0.088
Period III	0.319±0.161	0.874±0.090	0.725±0.059
Period IV	0.116±0.155	0.633±0.174	0.414±0.095
	Egg number × 40 week body weight		
Base Gen.	−0.241±0.168	0.271±0.356	−0.096±0.133
Period I	−0.080±0.127	−0.267±0.154	−0.174±0.088
Period II	−0.153±0.116	0.020±0.219	−0.091±0.093
Period III	0.090±0.152	0.411±0.122	0.298±0.082
Period IV	0.506±0.150	0.075±0.169	0.244±0.102

maturity, moderate and positive with 20 week body weight, and low but negative with 40 week body weight in base generation. These results were in agreement to the reports of Poggenpoel and Erasmus (1978), Singh et al. (1986), Chaudhary et al. (1988), Poggenpoel and Duckitt (1988) and Brah et al. (1991). The higher estimates of r_G from sire components suggested that genetic correlation of egg number with all the correlated traits except 20 week body weight is primarily influenced by sex-linked genes in base generation.

The relationship that changed drastically over the period of selection was between egg number and 40 week body weight which changed to moderate to highly negative values in second half (Period Ⅲ & Ⅳ) from moderately positive estimates in first half of the selection period, and the association between egg number and egg weight declined in later periods of selection (figure 2). As the pleiotropic effects of genes are the main reason for genetic correlation, segregation of pleiotropic genes affecting both the traits may be responsible for the change in direction and/or magnitude of a genetic correlation (Lerner, 1950). Simultaneous selection for two traits in opposite direction, which may be as a correlated response in another trait will cause a positive change in the genetic correlation as the only genes left segregating will be pleiotropic ones affecting both traits in the same direction, thus may result into the change in direction of the correlation after number of generations of selection. In general, Bohren et al. (1966) suggested that the genetic correlation is more likely to change under selection in comparison to the heritability.

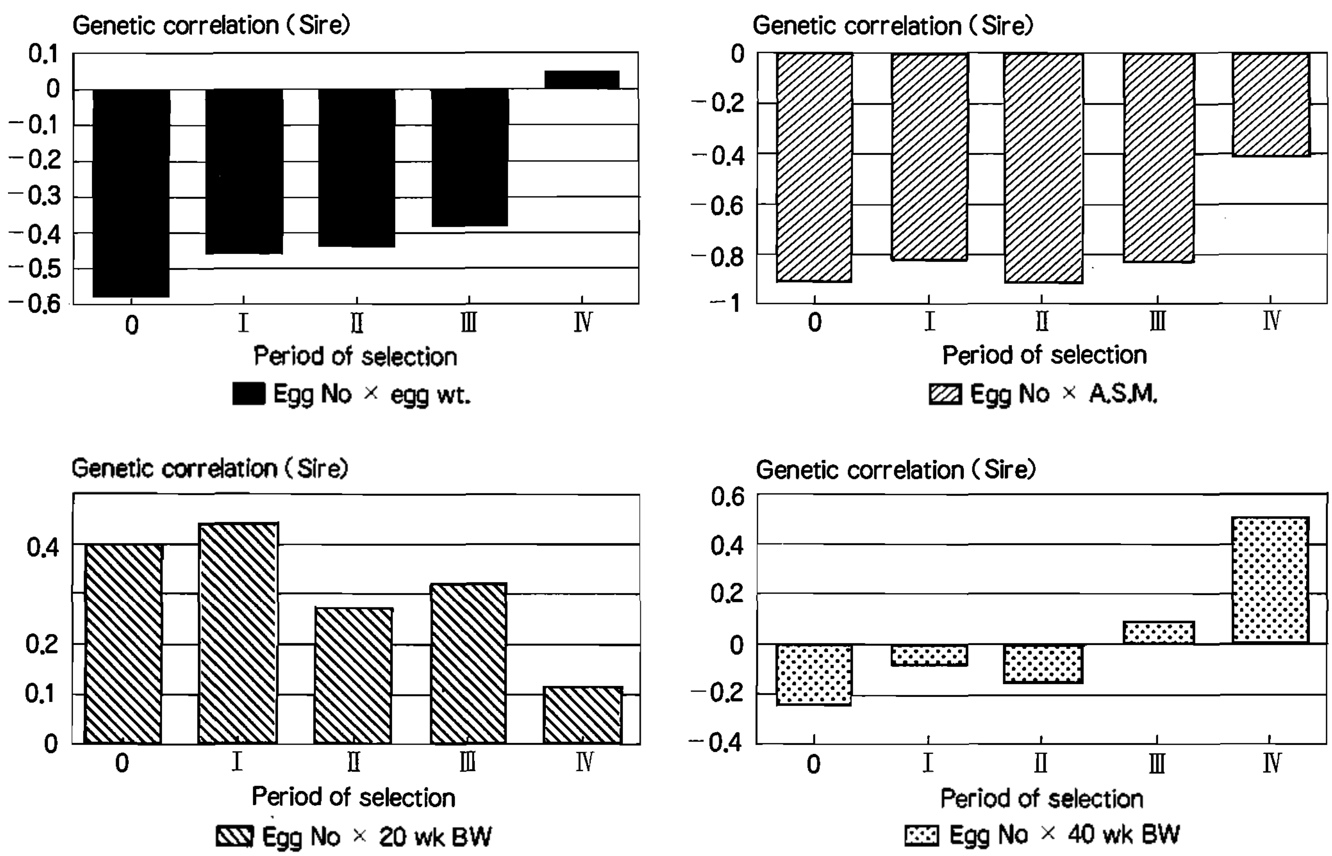

Figure 2. Genetic correlation (Sire) between the selected and unselected traits in WL.

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