



Time trends in genetic parameter estimates of production traits in White Leghorn chicken under long-term selection*

B L N REDDY¹, RAJVIR SINGH² and M C KATARIA³

Central Avian Research Institute, Izatnagar, Uttar Pradesh 243122 India

Received: 29 January 2011; Accepted: 11 May 20110

Key words: Correlations, Heritability, Long-term selection, Time trends, White Leghorn

Selection of layers changes the genetic constitution of the population over generation to generation. Additive genetic variation which measures the heritability of the population also changes. Genetic and phenotypic correlation between the traits will be subjected to change as selection progresses. Investigation pertaining to the effects of selection on genetic correlations had been very limited. However, Lerner (1958) presented theoretical models which allow for a change from positive to a negative genetic correlation between two traits on which selection was applied. The negative trend of heritability as a result of selection was observed by Grewal *et al.* (1995). Negative-time trends in the genetic correlations were observed by Friars *et al.* (1962). The present investigation mainly aims to study changes in the heritabilities, genetic and phenotypic correlations between traits in a White Leghorn chicken undergoing long-term selection for egg production.

White Leghorn population i.e. IWH strain maintained at experimental layer farm, Central Avian Research Institute, Izatnagar was utilized in the present investigation. Data were collected over 24 generations and analysed in 5 periods separately, consisting of 5 generations in each period and pooled over periods. The main emphasis of the selection was egg number up to 40 weeks of age based on Osborne Index (Osborne 1957a,b). In order to keep the inbreeding low-full-sib and half-sib mating were avoided.

All the generations were discrete and the length of each generation was 1 year. Mainly artificial insemination was practiced to reproduce the next generation except for the first 3 or 4 generations, during which natural mating was practiced. The birds were fed on starter diet during 0–8 weeks of age, grower diet during 9–20 weeks of age and layer ration after 20 weeks.

*Part of the Ph.D thesis of the first author.

Present address: ¹Senior Scientist (e mail: blnreddy2006@yahoo.co.in), PDP, Rajendranagar, Hyderabad.

²Retired Director (e mail: mckatariamailbox @rediffmail.com),

³Principal Scientist.

Generally 3–6 hatches were taken in each generation period. They were brooded on litter up to 6–8 week of age. Housing was done in individual laying cages at about 18 weeks of age. The traits measured included body weight at 20 and 40 weeks of age, age at sexual maturity, egg weight at 40 weeks of age and egg production to 40 weeks of age.

Statistical procedure: Data were analysed using model 4 (Harvey 1975) which included sires, dams within sires and progeny within dams as random effect and hatch as fixed effect. Only hatch corrected data were used for the estimation of the genetic parameters. The heritability was estimated by using variance component analysis (King and Henderson 1954). The genetic and phenotypic correlations were estimated in each generation and also in each of the generation period from variance-covariance component analysis as per Becker (1964).

Heritability: Time trends in the estimates of the heritability (h^2S) from different periods and over all periods for different traits are presented in Table 1.

Egg production: A significant decline in heritability from sire component was observed in the overall period, which indicated that additive part of genetic variance for part period, egg number declined over generations. Comparatively lower estimates of heritability of egg number from sire component in the later part of the study provides an additional evidence for the decline in heritability. These results were in agreement with the reports of Poggenpoel and Erasmus (1978), Gowe and Fairfull (1985), Sharma (1994) and Chatterjee *et al.* (2000) reported a decline in heritability from sire component. In contrast to these reports Morris (1963), Craig *et al.* (1969) and Goher *et al.* (1978) did not find any evidence of decline in heritability and/or additive genetic variance.

Correlated traits: A significant decline in heritability from sire component was observed for egg weight in early as well as overall period (Table 1) which may possibly due to depletion of additive genetic variance because of indirect selection for it. Similarly for age at sexual maturity there was a decline in heritability from sire component. For 20

Table 1. Linear regression coefficients for heritability (s) of important economic traits on generation numbers in IWH strain

Period	ASM	20wk BW	40wk BW	40wk EW	40wk EP
1	-0.05±0.06	-0.01±0.05	0.008±0.10	0.02±0.09	-0.09*±0.02
2	-0.06±0.02	0.06±0.04	0.12*±0.02	0.06±0.03	-0.05±0.02
3	-0.002±0.06	-0.04±0.04	-0.05±0.06	-0.15±0.06	-0.04±0.03
4	0.08**±0.01	0.007±0.002	-0.04±0.01	0.008±0.05	-0.04±0.03
5	0.03±0.01	-0.04±0.06	0.01±0.03	-0.09±0.06	-0.07±0.08
Overall	-0.005±0.003	-0.006±0.004	-0.01±0.005*	-0.01±0.005*	-0.001±0.004

**, P<0.01; *, P<0.05.

week body weight no significant change in the heritability from sire component reflects that it did not seem to be affected significantly as a result of direct selection for egg production. On the other hand for 40 wk body weight the heritability was declined significantly. Reports dealing with the change in heritability of correlated traits as a result of selection for part period egg production are very few. Friars *et al.* (1962) reported a significant decline in heritability of egg weight from sire component. Heritability did not show any significant change for adult body weights. Poggenpoel and Erasmus (1978) did not observe any change in heritability of correlated traits such as age at sexual maturity and egg weight. Gowe and Fairful (1985) did not find any significant trend in heritability of age at sexual maturity. In contrast to these reports a significant decline in heritability for egg weight, age at sexual maturity and 40 wk body weight was well evident in the overall period of 24 generations due to direct selection for part period egg number in the present investigation.

Genetic and phenotypic correlations: A significant decline in the magnitude of the negative association between egg number and egg weight was observed in the present study. This was in contrast to the reports of Poggenpoel and Erasmus (1978) and Liljedhal and Weyde (1980). The association between egg number and age at sexual maturity also declined over a period of 24 generations. An important association that showed a significant change was between egg number and 40 wk body weight which turned positive in later part of the study. The other association that also changed on genetic as well as phenotypic level was that of age at sexual maturity with 40 wk body weight, which showed a significant decline over generations.

The genetic cause of correlation is chiefly pleiotropy, though linkage is a cause of transient correlation particularly in populations derived from crosses between divergent strains. Falconer (1960), Lush (1948) and Lerner (1950) suggested that genes or gene block with independent desirable effect on either trait or with desirable pleiotropic effects on both traits will be fixed, while allelic genes with undesirable effects will be lost. Pleiotropic genes with desirable effects on one trait and an undesirable effect on the other trait will remain segregating, thus producing the negative change. Simultaneous selection for two traits in opposite direction

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. A significant positive change in genetic association between egg number and egg weight and between egg number and age at sexual maturity may possibly due to segregation of pleiotropic genes affecting both the traits in the same direction. Similar argument may also be possible for development of a positive genetic association between egg number and 40 wk body weight and in the course of selection for egg number. In the present investigations sufficient evidences proved that the genetic and phenotypic correlation between the traits specially between the selected and correlated traits have changed due to selection and were in confirmation to the findings of Friars *et al.* (1962), Bohren *et al.* (1966), Sharma (1994), Chatterjee *et al.* (2000).

SUMMARY

In the present study, nonsignificant negative-time trends for heritability estimates were obtained for the majority of the traits. It indicated that additive genetic variance of the traits in the population was reduced, but not significantly due to selection for egg production. Time trends in genetic and phenotypic correlations were mostly nonsignificant indicating that the association between different traits did not change significantly due to selection over generations.

REFERENCES

- Bohren B B, Kinney T B, Wilson S P and Lowe P C. 1970. Genetic gains in annual egg production from selection on part period egg production in the fowl. *Genetics* **65**: 655–67.
- Chatterjee R N, Misra B S and Singh H N. 2000. Time trends in estimates of genetic parameters in a White Leghorn population subjected to long-term selection. *Indian Journal of Animal Sciences* **70**(2): 184–87.
- Craig J V, Biswas D K and Saadesh H K. 1969. Genetic variation and correlated response in chickens selected for part year rate of egg production. *Poultry Science* **48**: 1288–96.
- Falconer D S. 1960. *Introduction to Quantitative Genetics*. Oliver and Boyd Ltd, Edinburgh, London.
- Frairs G W, Bohren B B and McKean H N. 1962. Time trends in estimates of genetic parameters in a population of chickens subjected to multiple objective selection. *Poultry Science* **41**: 1773–84.

- Gohar N E, McGibbon W H, Rutledge J J and Chapman A B. 1978. Evaluation of selection methods in poultry breeding program. I. Selection for rate of egg production on the basis of part year record with and without full sibling. *Egyptian Journal of Genetics and Cytology* **7**: 91–107.
- Gowe R S and Fairfull R W. 1985. The direct response to long-term selection for multiple traits in egg stocks and changes in genetic parameters with selection. *Poultry Genetics and Breeding*. (Eds) Hill W G, Mansom J M and Hewitt D. *British Poultry Science Symposium* 18.
- Grewal P, Singh R P and Jitendra K. 1995. Effectiveness of two stage selection for improving genetically antagonistic traits in egg type chicken. 1. Genetic and phenotypic variability. *Indian journal of Poultry Science* **30**: 95–100.
- Harvey W R. 1975. Least-square analysis of data with unequal sub-class numbers USDA, ARS, H-4.
- King S C and Hederson C R. 1954. Variance component analysis in heritability studies. *Poultry Science* **33**: 147–54.
- Lerner J L. 1950. *Population Genetics and Animal Improvement*. Cambridge University Press. London.
- Lerner I M. 1958. *The Genetic Basis of Selection*. John Wiley and Sons Inc, New York.
- Becker W A. 1964. *Manual of Procedures in Quantitative Genetics*. Washington State University, Pullman, Washington.
- Liljedhal L E and Weyde C. 1980. Scandinavian selection and cross breeding experiment with laying hens. 2. Results from the Swedish part of the experiment. *Acta Agriculturae Scandinavia* **30**: 237–60.
- Lush J L. 1948. *The Genetics of the Population*. Ames, Iowa.
- Morris J A. 1963. Continuous selection for egg production using short-term records. *Australian Journal of Agricultural Research* **14**: 909–25.
- Osborne R. 1957a. The use of sire and dam family average in increasing the efficiency of selective breeding under hierarchical mating system. *Heredity* **11**: 93–116.
- Osborne R. 1957b. Family selection in poultry: The use of sire and dam family averages in choosing male parents. *Proceedings of Royal Society, Edinburgh* **66**(4): 374–93.
- Poggenpoel D G and Erasmus J E. 1978. Long-term selection for increased egg production. *British Poultry Science* **19**: 111–23.
- Sharma D. 1994. 'Studies on long-term selection effects and evaluation of weight-free selection index in egg type chickens.' Ph.D thesis, IVRI Deemed University, Izatnagar, Uttar Pradesh, India.