GENETIC AND ENVIRONMENTAL VARIATION IN RELATION TO AGEING

G.Engström,L.-E.Liljedahl,M.Wilhelmson and K.Johansson
Department of Animal Breeding and Genetics
Swedish University of Agricultural Sciences
S-750 07 Uppsala,Sweden

SUMMARY

This study deals with the structure of additive genetic and environmental variation as well as genetic correlations for egg number at different ages in laying hens.The positive genetic correlations between early and late egg production together with an increase in additive genetic,and environmental variation found,give support for some of the theories of ageing.

INTRODUCTION

To be able to increase lifespan and lifetime production capacity in our domestic animals,it is important to obtain more knowledge about reproductive fitness and the fundamental causes of ageing.

One of the evolutionary theories of ageing is the pleiotropy theory (Williams,1957),which suggests that ageing is caused by pleiotropic genes with beneficial effects on early fitness but unfavourable effects on late fitness.This theory postulates negative genetic correlations between early and late fitness. Another main evolutionary theory is the mutation accumulation theory (Medawar,1952).This theory suggests that late-acting deleterious mutations accumulate with age.The mutations tend to accumulate because of their small effect on early fitness.

A third theory (Liljedahl et al.,1984) is that genes are turned on during ageing,to counteract the negative effects of increasing sensitivity to environmental stress.A fourth theory suggested by Engström et al. (1989) among others,is that ageing could be caused by accumulation of genetic damages with small effects.The different effects on the individual level reflecting genetic differences in DNA repair capacity.

In a study by Liljedahl et al. (1984),increasing genetic and environmental variation with age was found for egg production traits in a population of laying hens.Rose and Charlesworth (1980) found decreased early fitness,when selecting for late fitness in *Drosophila melanogaster*.However,they could not detect any trend in genetic variation with age.In another investigation dealing with *Drosophila melanogaster*,Engström et al. (1989) found increasing genetic and environmental variation with age and positive genetic correlations between early and late fitness.

This study investigates genetic and environmental variation, as well as genetic correlations for a fitness trait at different ages in laying hens.

MATERIAL AND METHODS

The data used was taken from a line selected for egg weight in the Scandinavian selection and crossbreeding experiment with laying hens (Liljedahl and Weyde,1980).Data from four generations for the trait egg number divided into five age periods (26-32,33-39,40-46,47-53 and 54-60 Weeks) during the laying year was used.

Only hens surviving the complete experimental period (90 %) are included in data to avoid selection bias caused by mortality. Number of eggs layed declined with age and to make the variances for the different age periods comparable data was transformed to a logarithmic scale before analysis.All variance and covariance components were calculated within generation using Multivariate Restricted Maximum Likelihood under an animal model (Meyer,1986).

RESULTS

In tables 1,2 and Figure 1.,means over the four generations for the different parameters are presented.As can be seen from Table 1. the number of eggs layed decreases throughout the laying year.Table 2. presents heritabilities and correlations for the different age periods. With a few exceptions all correlations are significantly positive and no correlations are negative. Figure 1. shows a clear increase in both additive genetic and environmental variance with age.A significant regression line can be fitted for both components of variance ($p<0.05$ for additive genetic and $p<0.001$ environmental).

Table 1 Descriptive statistics for egg number at different ages

Age (weeks)	N	Mean	Standard deviation
26-32	1506	34.0	1.9
33-39	1506	34.9	1.8
40-46	1506	33.2	1.9
47-53	1506	30.5	3.6
54-60	1506	30.9	1.8

Table 2 Genetic correlations (below), phenotypic correlations (above) and heritabilities (on diagonal) for egg number at different ages

	Age				
Age (weeks)	26-32 (weeks)	33-39 (weeks)	40-46 (weeks)	47-53 (weeks)	54-60 (weeks)
26-32	0.26±.06	0.40±.05	0.21±.03	0.18±.02	0.15±.05
33-39	0.72±.15	0.26±.03	0.42±.03	0.32±.06	0.26±.05
40-46	0.57±.23	0.91±.08	0.28±.20	0.40±.05	0.22±.05
47-53	0.28±.23	0.76±.12	0.82±.16	0.16±.05	0.34±.07
54-60	0.24±.36	0.60±.27	0.40±.32	0.64±.19	0.14±.07

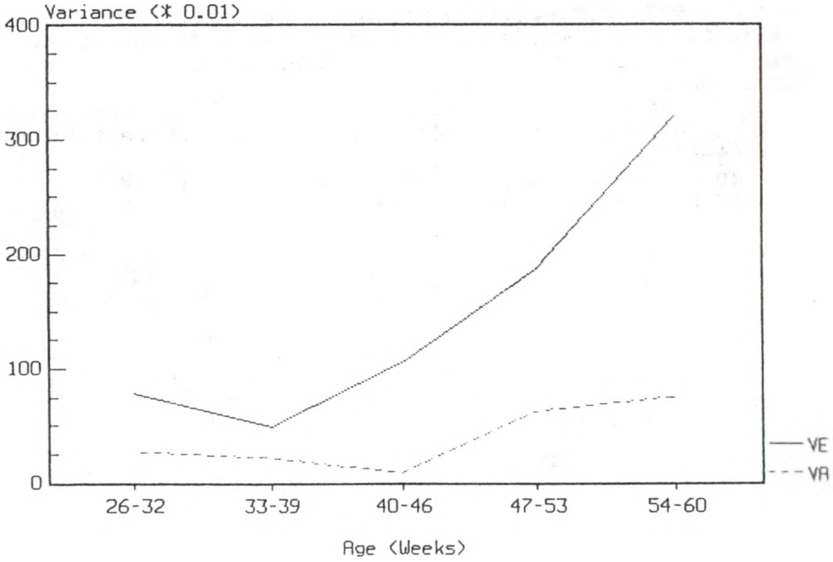

Figure 1. Additive genetic (VA) and environmental (VE) variation at different age periods for egg number.

DISCUSSION

The positive genetic correlations found between early and late fitness do not support the pleiotropy theory,which suggests negative genetic correlations.Increasing environmental variation with age has been found in several studies (Clayton and Robertson ,1966;Flock,1977;Rose and Charlesworth,1980).The most probable explanation to this phenomenon,is that the animals get increasing difficulties to cope with environmental stress when getting older.The increase in additive genetic variation relative to age supports the Mutation accumulation theory of ageing,and the other two theories mentioned above,genes turned on with age,and different DNA repair capacity.

REFERENCES

Clayton,G.A. and Robertson,A. 1966. Br.Poult.Sci. 7:143-151
Engström,G.,Liljedahl,L.-E.,Rasmuson,M. and Björklund,T. 1989. Theor.Appl.Genet. 77:119-122
Flock,D.K. 1977. Z.Tierz.Zuchtungsbiol. 94:80-103
Liljedahl,L.-E. and Weyde,C. 1980. Acta Agric.Scand. 30:237-260
Liljedahl,L.-E.,Gavora,J.S.,Fairfull,R.W. and Gowe,R.S. 1984. Theor.Appl.Genet. 67:391-401
Medawar,P.B. 1952. An Unsolved Problem of Biology (Lewis,London)
Meyer,K. 1986. Proc. 3rd World Congr.Genet.Appl.Livest.Prod. XII:454-459
Rose,M. and Charlesworth,B. 1980. Nature 287:141-142
Williams,G.C. 1957. Evolution 11:398-411