SHELL QUALITY, EGG NUMBER AND EGG WEIGHT; THEIR HERITABILITY AND THE CORRELATIONS BETWEEN THEM

Calidad de la cascara, produccion de huevo y peso del huevo; su heredabilidad y las correlaciones entre ellas

G. ENGSTROM *

SWEDEN

INTRODUCTION

Egg-shell cracking is a serious economic liability in the poultry industry in Sweden; its cost has been estimated at about 20 million Sw. Crowns per year. The percentage of cracked eggs increases with the production period. If the production period is to be prolonged, it will be necessary to develop a method for improving shell quality.

There are several ways to measure shell quality. The most common measures are; specific gravity, shell deformation, shell thickness, and breaking strength. However, estimates of the correlation between these indirect measures of shell quality and the frequency of cracked eggs are few. Estimates of heritability for shell quality, as measured by frequency of cracked eggs, and genetic correlations between this trait and productivity traits are seldom found in the literature.

In a literature review, van Tijen and Kuit (1970) found an average value of 0.39 for heritability estimates on different measures of shell quality, whereas the heritability of the rate of egg breakage was estimated as being 0.48±0.05, by Garwood et al. (1979), who used an impact loading procedure.

In the literature review by van Tijen and Kuit (1970), the genetic correlation between shell quality and egg number was found to be -0.12 on average, and between shell quality and egg weight it averaged 0.10.

The object of the present study was to estimate the heritability for shell quality as measured by frequency of cracked eggs, and the genetic correlations between this trait, egg number and egg weight.

MATERIAL AND METHODS

The investigation was carried out with a White Leghorn line selected for an index of egg number and egg weight. This line originated from the base population formed at the Dept. of Animal Breeding and Genetics in 1969 as described by Liljedahl et al. (1970) and Liljedahl and Weyde (1980). The data used in this investigation were collected from 368 laying hens, which survived the whole experimental period. The hens were daughters of 19 sires and 111 dams, with each sire mated to 5 or 6 dams.

The hens were kept in individual cages, and fed a diet containing 2.6 Mcal/kg feed, 13 % crude protein, 3.1 % calcium and 0.7 % phosphorus ad lib.

The eggs from each hen were collected from the egg cradle. Egg number, egg weight and different types of cracks were recorded. Each egg was handcandled to determine the type of crack. The state of the shell was recorded by the

Swedish University of Agricultural Sciences, Department of Animal Breeding and Genetics, Poultry Breeding Experimental Section, Funbo-Lövsta, Expt. Station, S-755 90 Uppsala, Sweden

following code:

1. Star crack
2. Hair crack
3. Other cracks; e.g. eggs smashed against the cage floor at oviposition, or eggs damaged by the hens themselves

The eggs classified as code 3 were not weighed, as they often had damaged shell membranes, and were leaky.

In the spring of 1981, the eggs were collected twice a week in the period between 68 and 80 weeks of age. Altogether more than 18,000 eggs were collected, and of these approximately 3,000 were handcandled once more after transport to the packing station.

The frequency of cracked eggs was calculated for each of the different crack codes, and for the crack codes combined.

The heritabilities were estimated from the sire component of variance, and the genetic correlations were calculated from the sire variance/co-variance components (Falconer, 1960). The standard errors of the heritability estimates were computed according to the formula published by Swiger et al. (1964) as modified by Harvey (1977), and the standard errors of the estimates of genetic correlations were computed according to the formula published by Tallis (1959) as modified by Harvey (1977).

The statistical model describing an individual observation was as follows:

$$Y_{ijk} = \mu + S_i + D_{ij} + e_{ijk}$$

where

Y_{ijk} = observation of kth daughter of jth dam mated to ith sire

μ = common mean

S_i = effect of ith sire

D_{ij} = effect of jth dam mated with ith sire

e_{ijk} = a normally distributed random element of a single observation

RESULTS AND DISCUSSION

The results are presented in Tables 1 to 3.

Table 1. Descriptive statistics for the traits investigated

Trait	Mean	Standard deviation	Minimum value	Maximum value
Egg number	49.67	11.17		
Frequency of cracked eggs (all crack codes)	0.31	0.22	0.00	0.93
Frequency of star crack	0.09	0.07	0.00	0.31
Frequency of hair crack	0.05	0.04	0.00	0.18
Frequency of other cracks	0.17	0.18	0.00	0.90
Egg weight (all eggs weighed)	61.75	4.37		
Egg weight (star and hair crack)	62.25	4.62		
Egg weight (intact eggs)	61.72	4.34		
Egg weight (star crack)	62.37	4.70		
Egg weight (hair crack)	62.00	6.04		

There are no significant differences between the means of the egg weights.

Table 2. Estimates of heritabilities ($\pm$SE) and genetic correlations ($\pm$SE) for some traits investigated. Heritabilities on the diagonal and genetic correlations below the diagonal. The estimates are based on paternal half-sib data

	Trait		
Trait	Frequency of cracked eggs (all crack codes)	Egg weight (all eggs weighed)	Egg number
Frequency of cracked eggs (all crack codes)	0.48 ± 0.23		
Egg weight (all eggs weighed)	-0.14 ± 0.28	0.71 ± 0.31	
Egg number	-0.78 ± 0.33	0.00 ± 0.40	0.23 ± 0.16

Table 3. Estimates of phenotypic correlations between various traits. The estimates are based on full-sib data (Harvey, 1977)

Trait	Egg weight (all eggs weighed)	Egg number
Frequency of cracked eggs (all crack codes)	-0.07	-0.28
Frequency of star cracks	0.00	-0.02
Frequency of hair cracks	0.00	0.09
Frequency of other cracks	-0.08	-0.35

The rather high overall crack frequency of 0.31 was probably due to the high age of the hens, and the fact that they were kept in individual cages with a stiff wire floor.

The frequency of cracked eggs of those sent to the packing station was only 0.59% (i.e. 0.34% of the total number of collected eggs were cracked during transport). The few cracked eggs, found after transport to the packing station indicates that almost every egg cracked can be identified when collected from the egg cradle.

By calculating the frequency of cracked eggs, every egg laid by a single hen can be used to obtain a measurement of shell quality. This method of recording shell quality obviously includes a measurement of shell strength as well as of the hen's laying behaviour (Carter, 1970; Wood-Gush and Gilbert, 1969).

The estimates of genetic parameters have quite large standard errors, but each frequency is derived from 50 eggs, on average.

The heritability values of egg number and egg weight are generally in agreement with published figures (Liljedahl and Weyde, 1980; Pirchner and von Krosigk, 1973, among others), and the heritability estimate of frequency of cracked eggs is, in general, in agreement with published results of other measures of shell quality (King et al., 1963; van Tijen, 1977, among others). The estimates of genetic correlations show no evidence of genetic antagonism between shell quality and the productivity traits measured.

The heritability estimate for frequency of cracked eggs was quite high, which suggests the possibility of obtaining a large selection response for shell quality measured as frequency of cracked eggs, at a rather high age.

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SUMMARY

Data on shell quality, egg weight and egg number were obtained from a selectio line of White Leghorn between 68 to 80 weeks of age, during the spring of 1981 More than 18,000 eggs were handcandled, and the frequency of eggs cracked was calculated, as a measure of shell quality.

The heritabilities and the genetic correlations were derived from the sire component of variance. The heritabilities were as follows; egg weight. 0.71±0. egg number. 0.23±0.16; frequency of eggs cracked. 0.48±0.23.

The heritability values of egg number and egg weight are, in general, in agree with published figures, and the heritability estimate of frequency of eggs cracked is generally in agreement with published results of other measures of shell quality. The estimates of genetic correlations show no evidence of genet antagonism between shell quality and the other traits measured.

RESUMEN

Datos sobre la calidad de la cáscara, produccion de huevo y peso del huevo fueron obtenidos en un experimento realizado con un grupo de ponedoras White Leghorn de 68 a 80 semanas de edad, durante la primavera de 1981. Mas de 18 000 huevos fueron observados manual y opticamente y la frecuencia de huevos dañados fué calculada como una medida de la calidad de la cáscara.

Las correlaciones genéticas y heredabilidad fueron obtenidas a traves de componentes de variación de los padres. La heredabilidad de dichos análises fueron los siguientes; peso del huevo 0,71±0,31; numero de huevos. 0,23±0,16 frecuencia de huevos con daños en la cáscara. 0,48±0,23.

Los valores de heredabilidad obtenidos para el número de huevos y para su pe en general concuerdan con otros resultados publicados y la heredabilidad obtenida para la frecuencia de huevos con daños en la cáscara es en general similar a resultados obtenidos con otros métodos usados para el cálculo de calidad de la cáscara. Los valores obtenidos en dicha correlaciónes genética no muestran evidencia de genetico antagonismo entre la calidad de la cáscara y la produccion de huevos y peso del huevo.

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