RELATIONSHIP BETWEEN LAYING AGE AND REPEATABILITY OF EGG QUALITY TRAITS

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ABSTRACT

Repeatability of 22 -, 26, 30 - and 32 - week egg weight (EW)., shell thickness (ST), Haugh unit (HU), yolk index (YI)and shape index (SI) was estimated based on the first three eggs laid in the week by fifty - six commercial Harco pullets. There was a consistent increase in repeatability estimates for these traits as laying age progressed. The estimates ranged from 0.67 to 0.85, 0.53 to 0.84., 0.51 t0 0.87, 0.20 to 0.61 and 0.26 to 0.62 for EW, ST, HU, YI and SI, respectively. While repeatability of EW increased by 0.02 units per week, that of ST and HU increased by 0.03 and 0.04 unit per week, respectively. Repeatability of EW, ST and HU showed a linear relationship with age, whereas that of YI and SI showed a linear relationship with age, whereas that of YI and SI showed a curvilinear relationship with age. The general increase in repeatability of each trait with age indicates that fewer records will be required to adequately characterize the inherent producing ability of each hen for the trait as laying age progressed.

Key words: laying age, egg quality, repeatability

INTRODUCTION

Prediction of breeding value of an individual is very important in animal breeding as it enables the breeder to determine the transmitting ability of each hen for desired economic traits. Early estimation of the future most probable producing ability of each hen is of immense advantage from point of view of shortened generation interval and enchanced expected rate of annual genetic gain. Akinokun and Dettmers (1977) observed a high positive correlation between early and late egg production records.

In addition to the genotype of an individual, several nongenetic factors influence repeatability. Among these are age, maternal effects and environment. King and Hall (1955) reported varying repeatability coefficient values for egg quality traits at different seasons of the year and also noted a declining repeatability in the traits with increasing age in lay. Merrit *et al.* (1960), however, observed an increase in repeatability of same traits as laying period progressed. Decrease in maternal influence on egg characteristics as laying period proceeds has been reported by Kosin *et al.* (1952) and by Saadeh *et al.* (1968).

Repeatability coefficients of Haugh unit and shell thickness ranging from 0.39 to 0.72 and from 0.17 to 0.45, respectively have been reported (Godfrey *et al.,* 1954; Goodman, 1965; Ibe, 1984; King and Hall, 1955). Also, repeatability coefficients for egg weight, ranging from 0.57 to 0.78 have been reported by some researchers for birds of different ages and genetic backgrounds (Ayorinde and Sado, 1988; Goodman, 1965; Ibe, 1984; Scheinberg *et al.,* 1953) whereas a range of 0.42 to 0.51 has been observed for the same trait by Farnsworth and Nordskog (1955). Farnsworth and Nordskog (1955), Goodman (1965), King and Hall (1955) and Kotaiah *et al.* (1974) have reported a range of 0.35 to 0.68 for shape index.

The objective of this study is to determine the relationship between age and repeatability of egg weight and egg quality traits and hence provide further information regarding the age at which repeatability of these traits could be estimated with maximum efficiency.

MATERIAL AND METHODS

Material

Fifty-six pullets of the Harco strain were brooded for four weeks on deep litter floor.

The floor and feeding spaces provided were $0.23m^2$ and 11.5 cm per bird, respectively in the first three weeks, and $0.45m^2$ and 14.1 cm, respectively in subsequent weeks. Feed was given to the birds *ad libitum* and water was provided continuously. Intra-ocular vaccination was administered to the birds on arrival at the experimental station. At six weeks of age, the birds were randomly divided into two groups, with one group placed on *ad libitum* feeding and the other on skip-a-day feed restriction until they were 20 weeks age.At 20 weeks of age, the birds were housed individually in cages. Egg production of all birds was recorded and egg weight (EW), shell thickness (ST), shape index (SI), yolk index (YI) and Haugh unit (HU) based on the first three eggs laid by each bird at 22, 26, 30 and 32 weeks of age were determined. The USDA interior egg quality calculator was used to estimate HU (a parameter that is dependent on EW and albumen height). Yolk index was measured as the ratio of yolk width to yolk height, whereas SI was estimated as the ratio of egg width to egg length. The heights of albumen and yolk were determined with a micrometer screw gauge. Yolk width, egg length and width were measured with Venier calipers. The shell-minus-membrane thickness was the average of three measurements on the egg shell with membrane removed, taken around the equatorial region of the egg. A paper thickness gauge was used for this measurement.

Analytical Procedure

The following mixed model was fitted to the data on each of the traits:

$$Y_{ijk} = u + G_i + I_{ij} + e_{ijk} \quad \text{.................. (1)}$$

where Y_{ijk} is the kth observation on the jth individual within the ith group, u is the overall mean, G_i is the fixed effect of the jth group (full-fed versus restricted), I_{ij} is the random effect of the jth hen within the ith group, and e_{ijk} is the random error.

Harvey's (1987) Mixed Model Least-Squares and Maximum Likelihood programme was used to estimate the variance components required to estimate repeatability. Repeatability coefficient was estimated using expression (2).

$$R = \sigma_I^2/(\sigma_I^2+\sigma_e^2) \quad \text{.............. (2)}$$

where σ_I^2 is the variance component due to differences among individuals and estimates all the variances due to permanent portions of the record, and σ_{e2} is the error variance component. Expression (3), due to Becker (1984), was used to estimate the standard error of the estimated repeatability coefficient.

$$S.E.(R) = \frac{2(1-R)^2[1+(k-1)R]^2}{K(k-1)(n-1)} \quad \text{.......... (3)}$$

where k is the number of records taken on each individual, n is the number of individuals, and R is the estimated repeatability of a trait.

Both linear (4) and quadratic (5) models were fitted to the repeatability - age data for all traits to determine the actual relationship between the two.

$$Y_i = a + bx_i + e_i \quad \text{.......................... (4)}$$

$$Y_i = a + b_1x_i + b_2x_i^2 + e_i \quad \text{.........(5)}$$

where Y_i is the ith repeatability estimate for a trait, a is the intercept, b_i and b_2 are regression coefficients, x_i is the ith age of individuals, and e_i is the residual.

RESULTS AND DISCUSSION

Repeatability estimates of egg weight and the various egg quality traits at 22, 26, 30 and 32 weeks of age are given in Table 1. There was a general increase in the magnitutde of repeatability values of EW and egg quality traits as laying age advanced. This agrees with the observation of Merritt *et al.* (1960). The implication of high repeatability is that fewer records are required to characterize the inherent transmitting ability of individuals. This leads to some saving in the cost of collecting additional data.

Relative efficiency of using more than one record to characterize individuals for their transmitting ability for each trait is shown in Table 2. Relative efficiency of selection based on repeated records as compared with selection based on a single records is a reciprocal function of age. The decrease in relative efficiency with age indicates the adequacy of using fewer records per individual to satisfactorily characterize the inherent transmitting ability of individuals at older ages. This agrees with the report of earlier investigators (Akinokun and Detmers, 1977; Ayorinde and Sado, 1988; Ibe, 1984; Merrit *et al.*, 1960).

Regression models of repeatability on age of birds are presented in Figures 1-5. All regressions were significant, with high R^2 values (84, 90. 3, 90. 5, 99.2 and 99.6% for YI , EW, SI, ST and HU, respectively). Repeatability of EW, ST and HU increased linearly with laying age. The rate of increase was 0.02, 0.03 and 0.04 units per week, respectively. Curvilinear relationship was observed for YI and SI, and this suggests that there is an age at which repeatability in both traits is maximum. At this age (30 weeks) (Figs. 4 and 5), prediction of most probable transmitting ability of individuals for selection purposes is best done.

The observed increase in repeatability as laying age progressed could be due to progressive decline in maternal influence on these egg charcteristics (Kosin *et al.*, 1952; Lasley, 1968; Merritt *et al.*, 1960; Saadeh *et al.*, 1968). Thus, as pullets get older, the environmental influence on egg weight and quality wanes, the true breeding value of the individual unfolds and the observable variations become solely due to the genetic make-up of the individual.

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Table 1: REPEATABILITY ESTIMATES OF EGG WEIGHT AND EGG QUALITY TRAITS AT DIFFERENT AGES.

	Age (weeks)			
Trait [a]	**22**	**26**	**30**	**32**
EW	.67	.72	.85	.83
	(0.060)	(.054)	.033)	(.037)
ST	.53	.68	.78	.84
	(.080)	(.060)	(.046)	(.035)
HU	.51	(.065)	.82	(.87)
	(.082)	(.064)	(.038)	(.029)
YI	.20	(.56)	.49	.61
	(.100)	(.074)	(.082)	(.070)
SI	.26	.53	.62	.61
	(.090)	(.077)	(.069)	(0.71)

a EW -egg weight ST = shell thickness HU = Haugh unit
YI = yolk index SI = shape index. Standard errors are in parentheses

Table 2. RELATIVE EFFICIENCIES OF CHARACTERIZING INDIVIDUALS ACCORDING TO THEIR INHERENT PRODUCTION POTENTIALS AT DIFFERENT AGES.

		Age (weeks)			
Trait [b]		**22**	**26**	**30**	**32**
EW:	R.E. (%)	13 - 17	11 - 14	5	6
	No. of records , k	3 - 5	3 - 5	3	3
ST:	R.E.	24 - 28	15 - 17	8	6
	K	4 - 6	4 - 6	3	3
HU:	R.E.	83 - 89	26 - 28	23	21
	K	8 - 10	6 - 8	5 - 7	5
YI	R.E.	83 - 89	26 - 28	23	21
	K	8 - 10	6 - 8	5 - 7	5
SI:	R.E.	68 - 73	27 - 29	16	21
	K	8 - 10	5 -7	4 - 6	5

a Values are relative to a single record on each individual
b See Table 1 for meanings of trait abbreviations
R.E. = Relative efficiency

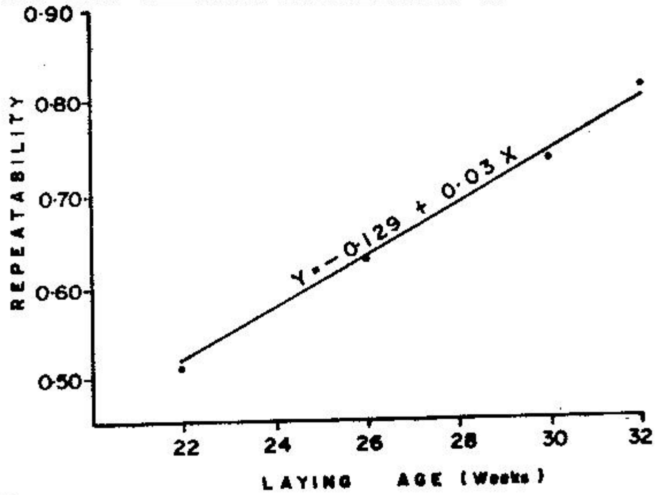

FIG. 1
Relationship between repeatability of egg weight and laying age

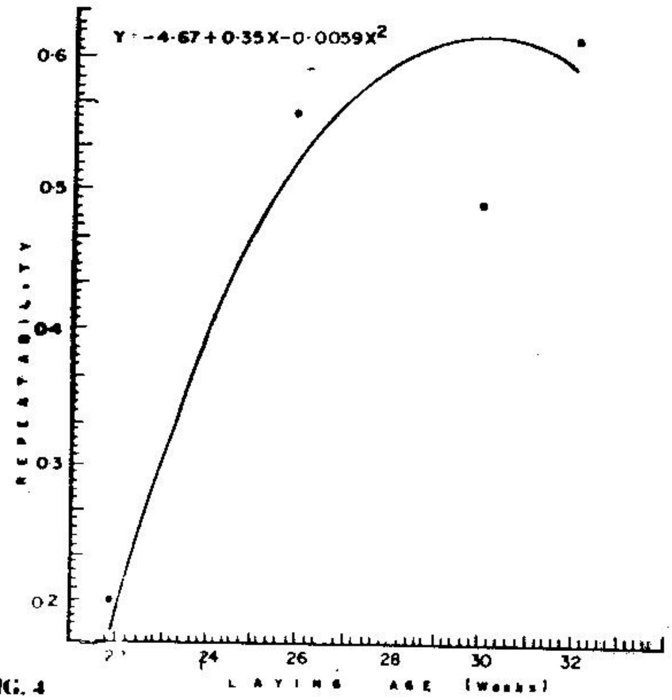

FIG. 4
Relationship between repeatability between repeatability of yolk index and laying age

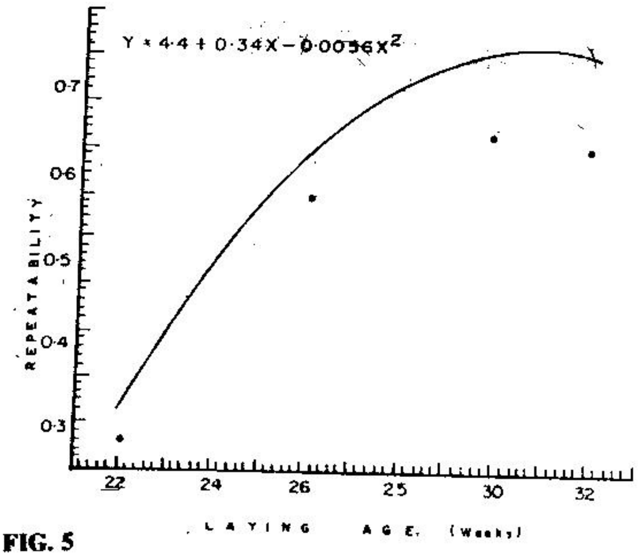

FIG. 5
Relationship between repeatability of shape index and laying age

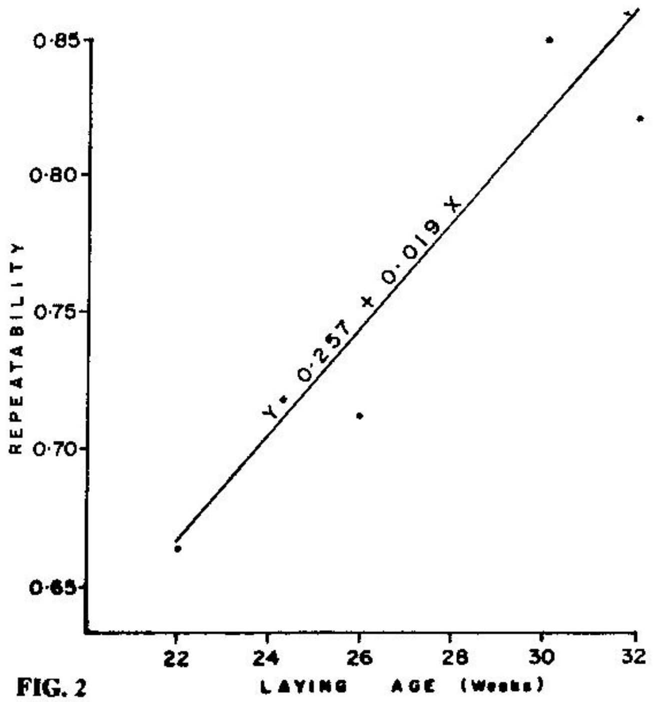

FIG. 2
Relationship between repeatability of shell thickness and laying a

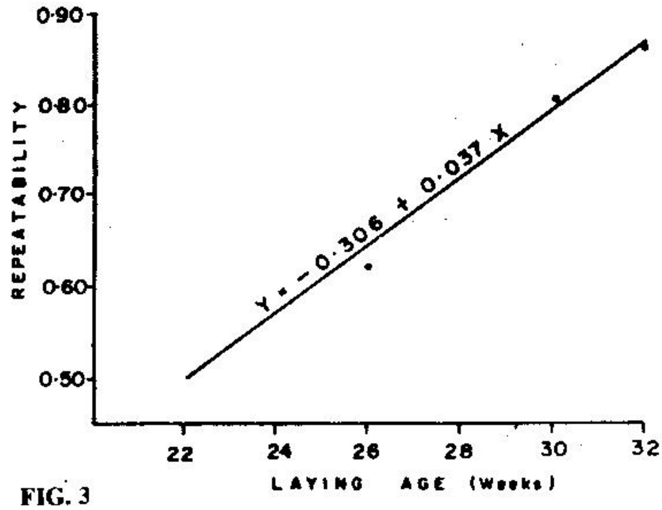

FIG. 3
Relationship between repeatability of Haugh unit and laying ag