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SIGNIFICANT GENETIC PARAMETERS FOR EGG, CHICK AND JUVENILE WEIGHT TRAITS IN OSTRICHES

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SUMMARY

Estimates of genetic parameters for egg weight (EWT), day old chick weight (CHWT), and liveweights recorded at ten (LW10) and 14 months of age (SLWT) in ostriches were obtained under an animal model using 24,745 egg records from a large commercial South African operation. Heritability estimates for these traits were generally moderate to high (0.21, 0.13, 0.42, 0.45). Age of the breeding hen influenced egg and subsequently chick weights. Furthermore, additional random effects of hen (independent of age) and breeding paddock were significant for egg (0.26 and 0.38) and chick weights (0.31 and 0.29), but insignificant for weights recorded at later ages. Parameter estimates obtained indicate that selection for improved performance is possible in ostriches.

Keywords: Ratite, heritability, variances, animal model

INTRODUCTION

In established livestock industries genetic evaluation systems have enabled selection of superior breeding stock for many traits, and resulted in visible genetic improvement. However, for relatively new industries, such as the ostrich industry, little is known about the genetic basis of observed variation in recorded traits, and breeding programs are yet to be developed. Use of selection to improve productivity implies that the selected traits are under some degree of genetic control. Genetic parameters for traits recorded in ostriches have not been estimated previously. The potential contribution of genetic improvement to increased monetary revenue in commercial ostrich operations is usually derived from parameters estimated for similar traits in poultry. This is less than ideal given the very different management conditions under which ostriches are maintained.

Obtaining genetic parameters for performance traits of ostriches has been hindered by several factors. Firstly, colony mated ostriches share communal nests and the parentage of eggs will often be unknown. Such data obviously cannot be used for parameter estimation until parentage can be established using appropriate techniques (eg. DNA fingerprinting). Secondly, there is evidence to suggest that ostriches are induced breeders, territorial, and may create bonds with their mate when bred as pairs. Traditional mating strategies that allow for these characteristics (repeat mating of the same pair in the same breeding paddock, year after year) will compromise data structure with regards to parameter estimation. In addition, the potentially long productive life of ostriches limits the turnover of breeding stock. Management issues and large numbers of offspring also restrict breeding flocks to a small size. These factors currently contribute to a very limited pedigree depth for reproductive traits in particular, but also for other production traits.

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In this study, genetic parameters were estimated for egg, chick and juvenile weight traits of ostriches using data from a large commercial pair breeding flock located in South Africa. Knowledge of genetic parameters will facilitate the development of effective genetic evaluation systems in the ostrich industry. The identification of non-genetic factors also affecting these traits is implicit in this process.

MATERIALS AND METHODS

24,745 egg records were used from an ostrich breeding flock maintained on the Klein Karoo Agricultural Development Centre, near Oudtshoorn, South Africa. Parents of eggs were known, representing 159 different breeding pairs mated over six seasons. Two parental strains of birds (feather quality and commercial strains) were present in the data. A high percentage of pairs were repeat mated over years, often in the same breeding paddock, with only 16.5 % of breeders having more than one mate over time. Management of breeding pairs and eggs are described in Van Schalkwyk *et al* (1996) and Cloete *et al* (1998). All breeding pairs received the same diet throughout the annually defined ± 9-month breeding season. Day old chick weights were recorded for eggs which hatched, and liveweights were recorded at approximately ten and fourteen months for a limited number of birds reared to slaughter age. No incubation details for eggs, or management details for birds reared to slaughter, were included in the data set. Specific weighing dates were also not available, but it is known that chronological age varied within age groups. All chicks received the same complete diet during the growing out phase.

Appropriate fixed and random effect models were developed, and parameter estimates obtained, using ASREML software (Gilmour *et al.* 1998). This program estimates variance components under mixed models by restricted maximum likelihood, and employs an average information algorithm which concurrently provides estimates of standard errors for parameter estimates (Gilmour *et al.* 1995). An animal model, treating each egg record as an individual, was used to estimate variance components.

RESULTS AND DISCUSSION

Characteristics of the data are presented in Table 1. Substantial variation was evident for all recorded traits, as expected, with coefficients of variation ranging from 9.8 for egg weight to 14.8 for liveweight at 10 months. Distributions of records were approximately normal for all traits.

Significant fixed effects identified for each trait are presented in Table 2. Year and/or month effects were significant for all traits recorded. Age of hen at breeding further influenced egg and chick weights. Relatively low R^2 values for the fixed effects models for juvenile weights suggested that significant factors influencing recorded traits were unknown. By contrast, high estimates of random effects for egg and chick weights suggest that much of the variation in these traits would not be accounted for with additional fixed effects. However, use of incubation details for eggs and chicks or rearing and weighing details of juveniles may improve fixed effect modelling for these traits. Chick weight is highly correlated with egg weight in many avian species (Wilson 1991), being almost fully described by initial egg weight, incubation loss and weight of the remaining shell and residues. In this study egg and chick weights were considered as separate traits. Consequently, chick weight was unadjusted for egg weight. Similarly, juvenile weights were unadjusted for day old chick weight despite the presence of a significant positive relationship between these weights.

Table 1. Number of records (N), mean, raw data standard deviation (SD), coefficient of variation (CV) and data range for egg weight (EWT), day old chick weight (CHWT), and live weight at 10 months (LW10) or slaughter (SLWT)

Trait	N	Mean	SD	CV	Range
EWT (g)	24,745	1419	139	9.8	859-1,945
CHWT (g)	11,452	850	98	11.5	505-1,234
LW10 (kg)	843	82.7	12.2	14.8	44-120
SLWT (kg)	687	109	12.5	11.5	62-150

Table 2. The number of dams, sires and breeding paddocks represented, along with levels of fixed effects (ns=not significant, excluded from model) and proportion of variation explained by the fixed effects included in the model (R^2), for individual ostrich traits

Trait	Number of			Year	Month	Y×M	Hen age	R^2
	Dams	Sires	Paddocks	(Y)	(M)		class	(%)
EWT (g)	134	133	102	6	10	36	7	5.7
CHWT (g)	126	124	99	6	9	36	7	6.1
LW10 (kg)	72 (ns)	72 (ns)	64 (ns)	3	5 (ns)	11(ns)	6 (ns)	5.6
SLWT (kg)	77 (ns)	78 (ns)	69 (ns)	4	6	14(ns)	6 (ns)	14.2

Year: year of lay; **Month:** month of lay; **Y×M:** interaction term; **Hen age class:** class 1: 2-3 years old; class 2: 4-6; class 3: 7-9; class 4: 10-12; class 5: 13-15; class 6: 16-18; class 7: 19-20.

Strain effects. No significant differences between genetic group solutions of feather and commercial strains were apparent for egg weight, chick weight, and weights recorded at 10 months of age or slaughter. There was some indication ($P<0.10$) of direct (positive) and maternal (negative) heterosis for both egg and chick weights, although not significant at the 5 % level. Subsequently, genetic parameters presented in this paper were estimated from a model excluding terms for strain or heterosis.

Other fixed effects. As expected, seasonal effects such as year and month of recording significantly affected performance in the traits recorded. Age of the hen was a significant factor influencing egg and chick weights, but not liveweights recorded at later ages. Other factors examined that had no significant impact on any of the above traits included sex of chick (often unknown in juveniles) and age of the male bird at breeding.

Random effects. In addition to age of hen effects on egg and chick weights, significant additional random effects of the hen and breeding paddock were identified. These effects may occur due to reproductive characteristics of individual hens (eg. egg production differences) and variable suitability of breeding paddocks. Potential service sire effects were confounded directly with sire in these analyses, but are not expected to have any impact on egg or chick weight over direct genetic effects.

Estimates of genetic parameters for each trait, along with their standard errors, are presented in Table 3. With the exception of chick weight, heritability estimates for the remaining traits were moderate to high, indicating that improved performance may be achieved in these traits through selection. Estimates of heritability for juvenile weight traits are higher than those found in poultry (Koerhuis and McKay 1996), but suggested by a high repeatability for mature weight in ostriches (Van Schalkwyk *et al.* 1996). Large estimates for the additional random effects of hen and breeding paddock signify the importance of maternal and breeding paddock effects on egg and chick weights. The data did not allow the separation of maternal genetic from maternal environment effects.

Table 3. Heritabilities (h^2) and the additional random effects of the hen (c$^2_{hen}$) and breeding paddock (c$^2_{paddock}$), where significant, for egg weight (EWT), day old chick weight (CHWT), and lwt at 10 mths (LW10) or slaughter (SLWT), along with phenotypic variances (σ^2_p)

Trait	h^2	c$^2_{hen}$	c$^2_{paddock}$	σ^2_p
EWT (g)	0.21±0.06	0.26±0.06	0.38±0.07	22,493
CHWT (g)	0.13±0.06	0.31±0.06	0.29±0.07	11,900
LW10 (kg)	0.42±0.09	-	-	142
SLWT (kg)	0.45±0.10	-	-	136

Typical ostrich breeding practices complicate estimation of random effects because of confounding between mating pairs and their breeding paddock and the tendency to repeat mate established pairs over several seasons. Consequently, it can be difficult to distinguish between potential paternal, maternal and breeding paddock effects in the data. Additional analyses treating egg and chick data as repeated traits of the hen may help to elucidate the most appropriate random effect models for these traits. More suitable data for analysis will only be achieved with the introduction of innovative mating systems. Ostrich industries need to be challenged with this goal.

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REFERENCES

Cloete, S.W.P., van Schalkwyk, S.J. and Brand, Z. (1998) *Proc. 2nd Int. Sci. Ratite Conf.*. 55

Gilmour, A.R., Cullis, B.R., Welham, S.J. and Thompson, R. (1998) **ASREML.** NSW Agriculture Biometrics Bulletin No 3. 180pp

Gilmour, A.R., Thompson, R. and Cullis, B.R. (1995) *Biometrics* **51**: 1440

Koerhuis, A.N.M. and McKay, J.C. (1996) *Livest. Prod. Sci.* **46**: 117

Van Schalkwyk, S.J., Cloete, S.W.P. and de Kock, J.A. (1996) *Brit. Poult. Sci.*, **37**: 953

Wilson, H.R. (1991) *Wld Poult. Sci. J.* **47**: 5