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GENETIC VARIATION AND HERITABILITY OF OSTRICH WEIGHT TRAITS

A. Engelbrecht[1,2], S.W.P. Cloete[1,2], K.L. Bunter[3] and J.B. van Wyk[4]

[1]Department of Animal Sciences, University of Stellenbosch, Matieland 7602, South Africa
[2]Institute for Animal Production, Elsenburg 7607, South Africa
[3]Animal Genetics and Breeding Unit, University of New England, Armidale, NSW 2351
[4]Department of Animal, Wildlife and Grassland Sciences, University of the Free State, Bloemfontein 9300, South Africa

SUMMARY

Estimates of genetic parameters for ostrich weight traits (recorded from 1 to 12 months of age) were obtained with multiple-trait animal models. Heritability estimates ranged from 0.06 for 1-month weight to 0.36 for 11-month weight, generally increasing with age. Concurrent estimates for hen permanent environment effects were low, without a specific trend. Genetic correlations among weight traits were positive, although correlations between weight at 1-month of age and later weight traits were generally not significantly different from zero. Moderate to high heritability estimates and high genetic correlations amongst later weights indicate that selection for weight at ages higher than 7 months of age would be effective in improving weight at slaughter.

INTRODUCTION

Growth rate is an economically important trait that influences age at slaughter and slaughter income through its association with body weight, muscle development and degree of maturity. Ostrich producers rely mostly on weight as a criterion for slaughtering (Jarvis 1998). However, large variation in growth is common amongst ostriches (Deeming *et al*. 1993; Mushi *et al*. 1998), with birds in the same contemporary groups often not ready for slaughter at the same time.

Ostriches are generally being farmed extensively, exposing them to various environmental factors that influence growth (Jarvis 1998). This does not, however, explain the variation seen within flocks, which were consequently attributed to genetic factors (Du Preez *et al*. 1992; Deeming and Ayres 1994). Bunter *et al.* (1999) and Bunter and Cloete (2004) were the first to estimate genetic parameters for ostrich weights, showing that a genetic basis for growth did exist.

Continued improvement of data structures necessitates further investigation into genetic parameters for ostrich growth traits, to provide accurate information for future selection decisions.

MATERIALS AND METHODS

Pedigree and growth data were obtained from the pair-breeding ostrich flock maintained at the Oudtshoorn Research Farm, South Africa. Data from South African Black ostriches (*Struthio camelus domesticus*), hatched and raised under similar conditions from 1997 to 2008, were used. The ostriches are reared mainly in feedlot conditions, with balanced rations provided *ad libitum*. Weights were generally routinely recorded at monthly intervals from hatch to slaughter. However, farm operations and other constraints prevented weighing of all progeny at exact monthly intervals. The exact age at weighing was therefore always noted. The final dataset consisted of 6645 ostriches with weights recorded from 1 to 12 months of age, representing progeny of 319 sires and 313 dams. The pedigree file consisted of 7723 animals over 7 generations.

The ASReml program (Gilmour *et al*. 2006) was used for the estimation of fixed effects and (co)variance components. Fixed effects fitted included contemporary group, gender and hen age. Age at weighing was included as a linear covariate. Contemporary groups were defined as year by season of hatch. Season of hatch was defined as: early season – July to September, mid-season – October to December, and late season – January to March. The effect of hen age and gender was very small and of little biological relevance and was therefore not fitted. Log-likelihood tests were conducted in single-trait analyses to determine the most suitable random effects model for each trait. Subsequently, a series of 7 six-trait analyses were performed to estimate correlations.

RESULTS AND DISCUSSION

A summary of the data is presented in Table 1. Early weights were highly variable, significantly more so than is common for weights in livestock species (Safari *et al.* 2005). The coefficients of variation were also higher than those found by Bunter & Cloete (2004) for corresponding ages.

Table 1. Descriptive statistics of ostrich weight traits (N = number of records, SD = standard deviation, CV% = coefficient of variation)

Trait	N	Mean (kg)	SD	CV%	Range (kg)
1-month weight	4607	3.2	1.3	41.0	1-12
2-month weight	3885	9.3	4.6	49.6	2-32
3-month weight	3825	16	7.8	48.2	3-50
4-month weight	4236	25	10.4	41.7	5-60
5-month weight	4084	35	12.4	36	8-74
6-month weight	3375	42	13.5	31.9	9-82
7-month weight	3244	50	13.7	27.4	14-96
8-month weight	2519	57	14.2	25	20-108
9-month weight	2076	67	15	22.4	24-112
10-month weight	2035	74	15	20.2	30-118
11-month weight	2059	83	15	17.6	40-132
12-month weight	1819	88	13.5	15.3	48-138

Variance ratios. The inclusion of a direct genetic component in the operational model resulted in an improved log likelihood for all traits (Table 2), while the addition of the random effect of a hen permanent environmental effect was also significant for most traits. The random effects of animal and hen permanent environment were consequently retained in the multiple-trait models for all trait combinations.

Table 2. Log-likelihood (LogL) values of different models for ostrich growth traits; the best model is indicated in bold

Trait	FE	h^2	$h^2 + c^2$	$h^2 + m^2$	$h^2+m^2+c^2$
1-month weight	-2564.42	-2509.83	**-2497.35**	-2508.24	-2497.35
2-month weight	-6248.85	-6228.1	**-6219.63**	-6226.79	-6219.59
3-month weight	-7963.65	-7930.5	**-7923.4**	-7930.5	-7923.4
4-month weight	-10256.8	-10183.6	**-10175.1**	-10183	-10175.1
5-month weight	-10873.2	-10765.5	**-10755.9**	-10759.6	-10755.8
6-month weight	-9399.37	-9279.41	**-9263.59**	-9268.2	-9263.53
7-month weight	-9421.24	-9288.78	-9285.48	**-9282.72**	-9282.72
8-month weight	-7596.4	-7476.66	-7475.44	**-7474.38**	-7474.38
9-month weight	-6385.51	-6313.71	**-6307.24**	-6309.38	-6307.2
10-month weight	-6212.69	-6119.23	-6117.81	**-6116.56**	-6116.56
11-month weight	-6167.33	-6084.76	**-6081.54**	-6081.75	-6081.28
12-month weight	-5400.58	-5342.33	**-5338.2**	-5340.03	-5338.2

FE = fixed effects only; h^2 = FE + animal effect (A); $h^2 + c^2$ = FE + A + permanent environment of hen (Hen_1); $h^2 + m^2$ = FE + A + additive maternal genetic effect (Hen_A); $h^2 + m^2 + c^2$ = FE + A + Hen_1 + Hen_A

Estimates of genetic parameters for each weight trait, as averaged from the different six-trait models, are shown in Figure 1. Most of the heritability (h^2) estimates (3 or 4 per trait) for a specific age group were within a 0.04 range However, when analysed in specific combinations with other weights, some h^2 estimates were outside of this range. These included the estimate for 6-month weight when analysed together with 4-, 5-, 7-, 10- and 11-month weights; as well as the 7-month weight estimate obtained from the model including 3-, 4-, 8-, 9- and 12-month weights. The estimates generally exhibit expected trends, with h^2 estimates increasing with age (Nobre *et al*. 2003), while hen permanent environmental effects (c^2) remained at relatively low levels throughout. The results pertaining to h^2 were consistent with previous estimates of 0.21 for 6-month weight and 0.27 for 10-month weight, as obtained from a five-trait analysis (Bunter & Cloete 2004). These authors estimated c^2 at 0.06 at six months of age and at 0.11 for 11-months-old ostriches.

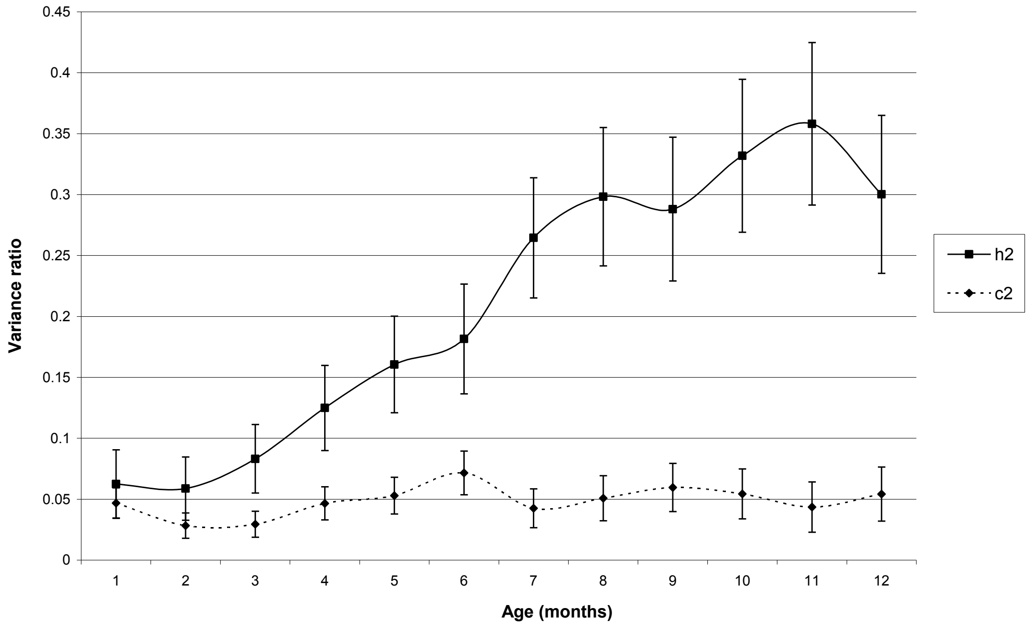

Figure 1. Variance ratios for direct additive (h^2) and maternal permanent environment (c^2) effects for ostrich weight traits at different ages

Correlations. Genetic correlations among weight traits were always positive, although correlations between 1-month weight and later weight traits were generally not significant from zero (Figure 2). Genetic correlations among later ages were close to unity, while all correlations among weight traits between 4 and 12 months were greater than 0.80.

CONCLUSION

One of the main questions that arise is how often ostriches have to be weighed, and at what ages should it be done? Similar estimates were obtained by Bunter and Cloete (2004), making use of only 5 weight classes. Monthly weighing therefore seems unnecessary if the breeding goal is to improve slaughter weight. Weight at 8 months of age should be a good basis for selection for improved weight at slaughter, having a moderate heritability (0.30 ± 0.06) and high genetic correlations with later weight traits (> 0.90). Improved weight at slaughter would result in improved financial gains since the unit price increases as total weight increases.

On the other hand, the possibility of rather reducing ostrich slaughter age through selection for weight, as was done in the poultry industry (Emmerson 1997), needs to be considered. Earlier slaughter is already being propagated in the ostrich industry due to high feed costs and the reduced economic yield from skins relative to meat. Breeding objectives have to be developed with all aspects of ostrich production in mind, however, since the ostrich have three primary products, namely meat, skin and feathers; each subject to different market conditions.

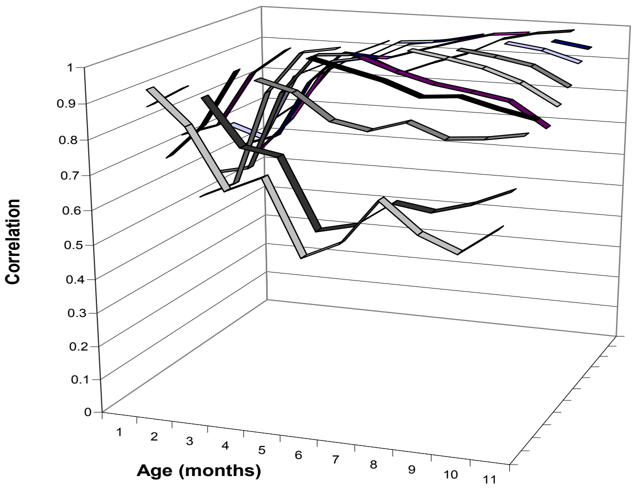

Figure 2. Genetic correlations among ostrich weight traits at different ages

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