FACTORS AFFECTING REPRODUCTIVE PERFORMANCE IN FARMED OSTRICHES

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SUMMARY

Complete egg production data from a pair breeding flock located in South Africa were used to generate annual reproductive records for all hens exposed to breeding. Traits analysed included measures of total egg and chick production and related traits, along with egg and chick weights. Both genetic and non-genetic factors significantly influenced reproductive performance. Seasonal effects, duration of the breeding season, hen age, and individual variation between hens were the key factors affecting total egg production and related measures. Variation between individual males, and their age, was important for traits related to egg fertility. With the exception of measures for clutching behaviour and fertility, which exhibited no additive variation, heritability estimates ranged between 0.07±0.08 to 0.19±0.10 for egg and chick production traits. Heritability estimates were substantially higher for average egg and chick weights (0.43±0.16 to 0.51±0.17). In combination with moderate repeatabilities and high levels of variation, these results indicate that appropriate culling strategies will improve reproductive performance in the current flock. Further, future gains through selection are likely in this species, although standard errors of heritability estimates were high.
Keywords: heritability, fertility, hatchability, egg production, age effects.

INTRODUCTION

Reproductive performance in farmed ostriches varies widely, and factors affecting reproduction in this species remain poorly quantified. In a commercial environment, profit from ostriches is significantly influenced by reproductive success, which ultimately determines the production of slaughter progeny. A better understanding of both non-genetic and genetic factors influencing reproductive performance is required to increase output and profit. The objective of this study was to develop and investigate alternative measures of reproductive performance in farmed ostriches, and subsequently quantify significant factors influencing reproductive success.

MATERIALS AND METHODS

Data. Records for all eggs produced in the 1991-1998 breeding seasons were obtained from a pair breeding flock maintained at the Klein Karoo Agricultural Development Centre (KKADC), located near Oudtshoorn, South Africa. Data contained the total output (~ 36000 eggs) from 195 hens and 191 males, comprising 242 different breeding pairs and records from up to four generations of hens. The complete details of the development and management of the flock were summarised by Bunter and Graser (2000), and are not repeated here.

Within each production season, records summarising annual reproductive performance were generated for each hen, including those with zero egg production. Individual egg records included information on egg weight and date of collection, incubation dates, the outcome for each egg (eg. not incubated, infertile, embryonic death, chick hatched etc.), day old chick weights, along with live weights for a limited number of chicks and juveniles. A total of 708 reproductive records were generated, representing the number of hen-seasons. Each record contained information on:

- time taken to commence laying (TTL) after formation of breeding pairs, along with the duration of lay (DUL), or time between first and last recorded egg of the season (both measured in days)
- number of clutches laid (NCL), where any sequence of eggs containing consecutive eggs laid within four days of each other are considered to constitute a single clutch
- total number of eggs laid (NLAID), incubated (NINC), infertile (NINF) or hatched (NHAT)
- average egg (EWT) and chick weights (CHWT)

Analyses. Models for analyses were developed, and parameter estimates obtained, using ASREML (Gilmour *et al.* 1998). This software estimates variance components under mixed models by restricted maximum likelihood, employing an average information algorithm which concurrently approximates standard errors for parameter estimates (Gilmour *et al.* 1995).

Given a relatively high level of confounding between hens and their mate(s) and/or breeding paddock in the data, a series of analyses were performed to evaluate alternative random effects models. These analyses were used to assess both the suitability of considering reproductive records as traits of the hen, and the significance thereafter of including additional random effects, such as mate and breeding paddock (assumed identically and independently distributed), in the models for analyses. The significance of changes in Log Likelihoods under alternative random effect models was assessed using the Likelihood Ratio Test. Subsequently, an animal model treating each hen as an individual, and allowing for repeated records by hens, was used to estimate variance components for each trait.

RESULTS AND DISCUSSION

Characteristics of the data are presented in Table 1. With the exceptions of average egg and chick weights, most traits were highly variable with large CV. Non-normal distributions for some variates were induced by amplified frequencies of valid zero records.

Systematic effects. Significant non-genetic factors affecting each trait are shown in Table 2. Seasonal effects (production year) and hen age significantly influenced most measures of reproductive performance, with the exception of NINF, while length of the breeding season (the time interval breeding pairs where together) predominantly determined measures related to output. Longer seasons allowed greater egg production when considered over an eight to nine month period. Age of hen effects were essentially curvilinear, with peak average egg and chick weights occurring in 3 to 7 year old hens, and peak chick production between 7 to 11 years. Hens older than 11 years produced fewer chicks from artificially incubated eggs than their two-year old counterparts. Age of the hen's mate also had significant curvilinear effects on egg fertility, with mates of 4 to 6 year old males producing fewer infertile eggs than females with either younger or older males.

Table 1. The number of records (N), along with their mean, median value, standard deviation (SD), coefficient of variation (CV) and range for reproductive traits in farmed ostriches

Trait†	N	Mean	Median	SD	CV	Range
TTL (days)	689	35.9	25	35.1	98.0	-1 to 230
DUL (days)	689	173	187	59.1	34.1	0 to 272
NCL	681	6.3	6	3.1	50.0	1 to 19
NLAID	708	51.1	52	26.5	51.8	0 to 121
NINC	689	48.6	48	24.8	51.0	0 to 108
NINF	689	10.4	5	14.2	137.1	0 to 96
NHAT	708	23.8	21	19.2	80.6	0 to 90
EWT (g)	689	1416	1413	128	9.0	963 to 1828
CHWT (g)	624	849	849	86.3	10.2	607 to 1138

†See text for trait abbreviations.

Table 2. Significant (P<0.05) factors affecting reproductive traits, along with the total proportion of variation they explain (R^2)

Factor / Trait†	Season	Length of season	Hen age class	Sire age class	R^2
TTL (days)	***	ns	***	ns	0.22
DUL (days)	***	***	***	ns	0.29
NCL	***	***	**	ns	0.11
NLAID	***	***	***	ns	0.22
NINC	***	***	***	ns	0.20
NINF	***	ns	ns	***	0.04
NHAT	***	***	***	ns	0.09
EWT (g)	*	ns	***	ns	0.07
CHWT (g)	***	ns	***	ns	0.13

***P<0.0001, **P<0.01,*P<0.05, ns = not significant

Random effects. Estimates of genetic parameters are presented in Table 3. Adding estimates of heritability to the permanent environmental effect of the hen approximates the repeatability of performance. No additive variation was apparent for the number of clutches laid or the number of infertile eggs. In contrast, heritability estimates were high for egg and chick weights, and low to moderate for the remaining traits. Despite relatively high standard errors, these results are consistent with summaries of estimates for similar traits reported in poultry (eg. see review of Kinney 1969), and suggest that improvement in reproductive performance in this species can be obtained through appropriate selection and culling strategies.

Specific breeding paddocks did not significantly affect the majority of traits, and accounted for relatively little variation in the number of clutches laid or egg weight. This could be expected given that paddocks were predominantly the same size and complete rations were provided, limiting the possibilities for differences between paddocks. The hen's mate also had no significant effect on measures indicative of egg output or weight but, in addition to their age effects, variation between individual males was particularly important for egg fertility. In addition to the obvious limitation infertility has on egg hatchability, towards the end of the season a male's history of fertility also influenced the number of his eggs that were incubated, and subsequently total chick production.

Table 3. Trait heritabilities (h^2), along with significant permanent environmental effects due to the hen (c^2_{hen}), breeding paddock ($c^2_{paddock}$) or mate (c^2_{mate}) as proportions of the total phenotypic variance (σ^2_p) for reproductive traits (standard errors in parenthesis)

Trait[†]	h^2	c^2_{hen}	$c^2_{paddock}$	c^2_{mate}	σ^2_p
TTL (days)	0.07 (.08)	0.11 (.08)	-	-	1004
DUL (days)	0.19 (.10)	0.01 (.08)	-	-	2633
NCL	-	0.12 (.06)	0.14 (.06)	-	8.81
NLAID	0.12 (.11)	0.32 (.10)	-	-	580
NINC	0.14 (.11)	0.21 (.12)	-	0.12 (.06)	517
NINF	-	0.23 (.06)	-	0.31 (.06)	223
NHAT	0.11 (.11)	0.33 (.12)	-	0.11 (.06)	353
EWT (g)	0.43 (.16)	0.25 (.12)	0.11 (.05)	-	15273
CHWT (g)	0.51 (.17)	0.25 (.16)	-	0.06 (.04)	7162

[†]See text for trait abbreviations.

CONCLUSIONS

Within flock reproductive performance is highly variable, and both non-genetic and genetic factors contribute towards differences in performance. Differences in seasonal effects, length of the breeding season and hen age should be allowed for if individual hens are to be compared for egg and chick production. Age of the male, and variation between individual males, are important considerations where egg fertility is poor. The presence of low to moderate heritabilities, repeatabilities of generally higher magnitude, and significant levels of variation suggest that both current and future flock performance can be improved through appropriate selection and culling strategies. The significance of non-normal trait distributions for results should be addressed in future studies.

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