

## Genetic Parameters for Early Reproduction Traits in Ostriches

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**ABSTRACT:** Genetic parameters were derived for first-season reproduction of 517 pair-mated ostrich females joined at an average age of 630 days. Traits were age at first egg (AFE), the interval from the first egg to the last egg in the season (INT), the interval from the start of mating to the first egg (TTL), total egg production (TEP) and total chick production (TCP). South African Black females had an increased INT, a reduced TTL with a higher TEP compared to Zimbabwean Blue birds. First-time breeders mated to older males generally had a higher TEP and TCP compared to females mated to young males. Heritability estimates were  $0.14 \pm 0.08$  for AFE,  $0.15 \pm 0.08$  for INT,  $0.26 \pm 0.10$  for TTL,  $0.34 \pm 0.09$  for TEP and  $0.17 \pm 0.07$  for TCP. Genetic correlations among traits suggested that a higher TEP and TCP would result in a lower AFE, a shorter TTL and a longer INT. Females with a lower AFE were likely to have a longer INT and a reduced TTL. Although the study is based on limited data, first-season production was heritable in ostriches. Genetic correlations of first-season production with records in subsequent years needs to be derived to determine if high-producing females could be selected on early production for an improved subsequent egg and chick output.

**Keywords:** egg production; chick production; heritability; genetic correlations

### Introduction

Commercial ostrich production is an important source of revenue for farmers in the Klein Karoo region of South Africa (Cloete et al. (2002)). The majority of South African ostrich farmers make use of flock mating systems (Lambrechts et al. (2004)), where males and females are mated in a group at a male:female ratio of approximately 6:10. This system, as well as the unique mating strategies of ostriches makes it very difficult to record pedigrees for genetic evaluation (Cloete et al. (1998); (2002); (2008c)). However, it has been feasible to derive genetic parameters for key ostrich production and reproduction traits using a pair-breeding system (Cloete et al. (2008c); (2012)). Genetic progress accruing as the result of selection for an improved reproduction rate has also been reported (Cloete et al. (2008b)).

So far, repeatability models were used for genetic parameter estimation of ostrich reproduction traits, and also to predict estimated breeding values to base selection decisions upon (Cloete et al. (2008b); (2008c)). Selection deci-

sions are thus mainly based on maternal performance, while no attention is given to the reproduction of females themselves. The decision to use repeatability models for this purpose is driven by the fact that there are only a limited number of age-specific reproduction records in the present database. This result is not surprising, given the high capital outlay of acquiring ostrich pedigree information (Cloete et al. (2002); (2008c)) and the fact that the average generation interval of the ostrich resource flock used in the studies is generally high at 7.7 years (Fair et al. (2012)).

The aim of this study is therefore to use 2-year-old reproduction records of ostrich females for the first time to estimate genetic parameters for early reproduction traits.

### Materials and Methods

**Data.** Experimental animals were obtained from the commercial pair-bred ostrich flock at the Oudtshoorn research farm in the Klein Karoo of South Africa. The resource population is well described in the literature (Cloete et al. (2002); (2008c)). The flock consisted of 36 to 188 breeding pairs joined annually for approximately 7-8 months in pairs. The handling of eggs and artificial incubation practices at the farm are described by Brand et al. (2007), and the general husbandry are described by Bunter and Cloete (2004) and Cloete et al. (2008b). The resource population mostly consists of the South African Black (SAB) strain, but the Zimbabwean Blue (ZB) and Kenyan redneck (KR) strains are also represented (Cloete et al. (2008); Engelbrecht et al. (2008); Brand et al. (2012)). Reciprocal crosses of the SAB strain with the other strains are also available in the data. Two year-old reproduction records of 517 females that were hatched from 1990 to 2010 were used in the analysis. Traits that were considered included age at the first egg (AFE), the interval from the first egg to the last egg in the season (INT), the interval from the start of mating to the production of the first egg (TTL), total egg production (TEP) and total chick production (TCP).

**Statistical analysis.** ASReml software (Gilmour et al. (2009)) was used to assess the influence of the fixed effects of year of production (1992 to 2012), strain (SAB, ZB, KR and reciprocal crosses), the strain of the service sire (same or other) and the age of the service sire (same or older) initially in single-trait analyses. The number of days in production was included as linear covariate in the analyses on TEP and TCP. The random effect of animal was included as a single random effect in the analyses. The single-trait

analyses were followed by a series of three-trait analyses to obtain all the genetic correlations among the traits of interest. As the parameters derived from the single trait analyses did not differ appreciably from those in the three-trait analyses, only the former will be considered. A series of separate smaller analyses were conducted to assess the influence of strain (SAB and ZB and their reciprocal crosses) on 2-year-old female reproduction.

## Results and Discussion

Two-year-old ostriches produced their first eggs at just about two years of age (Table 1). All 2-year-old ostrich reproduction traits except AFE were highly variable with coefficients of variation exceeding 50% (Table 1). High coefficients of variation are common for ostrich reproduction traits (Cloete et al. (2008b); (2008c)), but it seems like 2-year-old reproduction is subject to even greater levels of variation. Also, means for TEP and TCP are substantially lower than comparable means for mixed age records (Cloete et al. (2008b); (2008c)). This result is not unexpected when the effect of female age on reproduction is considered (Bunter (2002); Cloete et al. (1998); (2006); Fair et al. (2011)).

**Table 1. Descriptive statistics of the 2-year-old ostrich reproduction traits that was included in the study**

Trait	Number of records	Mean	Standard deviation
AFE (days)	390	733	83
INT (days)	380	110	58
TTL (days)	391	105	77
TEP (n)	517	22	21
TCP (n)	517	9	12

AFE – age at the first egg, INT – the interval from the first egg to the last egg in the season, TTL – the interval from the start of mating to the production of the first egg, TEP – total egg production, TCP – total chick production

AFE was lower ( $P < 0.05$ ) in SAB females than in ZB females ( $714 \pm 10$  vs.  $744 \pm 10$  days respectively). The performance of females belonging to the reciprocal crosses between these strains was intermediate and not significantly different from either pure strain ( $P > 0.05$ ). The TEP of 2-year-old SAB females were also higher ( $P < 0.01$ ) than that of ZB contemporaries, respective least squares means amounting to  $27.7 \pm 2.7$  and  $17.7 \pm 2.6$ . Cloete et al. (2008a) accordingly reported that mixed-age SAB females outperformed ZB females for TEP. No conclusions could be made from the reciprocal cross between the pure strains, as 2-year-old ZB x SAB females resembled the ZB strain, while SAB x ZB females were closer to the midparent value. Females mated to older males generally exhibited a higher ( $P < 0.05$ ) reproduction than females mated to males of the same age. TEP for females mated to older males amounted to  $26.4 \pm 2.0$  compared to  $21.9 \pm 2.1$  for females mated to 2-year-old males. Corresponding values for TCP were respectively  $12.8 \pm 1.1$  and  $7.5 \pm 1.2$ . There was a

suggestion ( $P < 0.05$ ) that 2-year-old females mated to males of the same strain had a higher TEP than contemporaries mated to males of another strain (respectively  $26.4 \pm 2.0$  vs.  $22.0 \pm 2.1$ ). No results to support or refute these findings were found in the literature.

The heritability estimates of the 2-year-old reproduction traits ranged from 0.14 for AFE to 0.34 for TEP (Table 2). Estimates for AFE and INT did not reach a level of twice the corresponding standard error, but estimates for all the other traits were more than double the corresponding standard error. Previous repeatability model heritability estimates ranges from 0.12 to 0.29 for TEP and from 0.11 to 0.26 for TCP in the review of Cloete et al. (2008c). Previous heritability estimates for TTL and INT ranged from respectively 0.07 to 0.18 and 0.13 to 0.19 (Bunter et al. (2001); Cloete et al. (2005)). The present estimates for 2-year-old performance thus accorded fairly well with these earlier values.

**Table 2. (Co)variance ratios (s.e. in brackets) depicting genetic parameters for 2-year-old reproduction traits in ostrich females. Heritability estimates are in bold on the diagonal, genetic correlations above the diagonal and phenotypic correlations below the diagonal.**

Traits	AFE	INT	TTL	TEP	TCP
AFE	<b>0.14</b> (0.08)	-0.49 (0.36)	0.74 (0.16)	-0.77 (0.25)	-0.97 (0.08)
INT	-0.50 (0.05)	<b>0.15</b> (0.08)	-0.83 (0.20)	0.91 (0.09)	0.69 (0.21)
TTL	0.46 (0.05)	-0.55 (0.05)	<b>0.26</b> (0.10)	-0.76 (0.20)	-0.86 (0.23)
TEP	-0.47 (0.04)	0.65 (0.03)	-0.58 (0.04)	<b>0.34</b> (0.09)	0.94 (0.06)
TCP	-0.31 (0.05)	0.43 (0.04)	-0.40 (0.04)	0.79 (0.02)	<b>0.17</b> (0.07)

AFE – age at the first egg, INT – the interval from the first egg to the last egg in the season, TTL – the interval from the start of mating to the production of the first egg, TEP – total egg production, TCP – total chick production

Significant genetic correlations suggested that birds with a higher 2-year-old TEP would have a lower AFE, a shorter TTL and a longer INT (Table 2). Corresponding genetic correlations with TEP in the literature were 0.93 for INT and -0.57 for TTL when a repeatability model was used (Cloete et al. (2005)). The genetic correlations of AFE, INT and TTL with TCP followed the same trend as for TEP. Corresponding estimates of genetic correlations with TCP in the literature amounted to 0.88 for INT and -0.43 for TTL (Cloete et al. (2005)). Birds with a lower AFE would also have a shorter TTL. The genetic correlation between INT and TTL was high and negative (Table 2). A corresponding genetic correlation of -0.70 was previously reported by Cloete et al. (2005), using results from a repeatability model. The genetic correlation between TEP and TCP did not differ from unity, as was also reported previously on a number of occasions for mixed-age birds

(Cloete et al. (2005); (2006); (2008b)). It can thus be safely assumed that TEP and TCP are genetically very similar traits.

### Conclusion

The present study is the first report of significant genetic variation in reproduction of 2-year-old ostrich females. These results suggest that selection of replacement females on maternal performance may be augmented with selection on their own early performance, thus possibly accelerating the genetic gains that are achievable. In theory, it may also be feasible to base selection on own performance on part-records during the 2-year-old reproduction season of females. These aspects warrant further research.

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