GENETIC ASPECTS OF PREWEANING PERFORMANCE OF NDAMA CATTLE

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SUMMARY

Records on birth weight (BW), preweaning daily gain (PWG) and weaning weight (WW) of Ndama beef cattle were obtained from the Fashola Livestock Farm in Oyo State of Nigeria between 1954 and 1964 and were analyzed to estimate the phenotypic and genetic parameters of preweaning performances of this breed of cattle. For birth weight, preweaning daily gain and weaning weight respectively heritability was estimated as 0.13 ± 0.08, 0.30 ± 0.14 and 0.25 ± 0.12 from paternal half-sib relationship. The estimates of genetic and phenotypic correlations obtained from these data among the three pre-weaning traits were found to be similar to those already in the general literature on beef cattle.

INTRODUCTION

In a previous paper (Adeyanju, Akinokun and Ariyibi, 1976) a detailed report on the environmental aspects of preweaning performance of the Ndama Cattle was presented. To give a complete picture of the potentials of this increasingly important local breed of cattle, it is necessary to also examine the genetic aspects of its preweaning performances. In addition to such basic facts as the mean birth weight, and estimates of the effects of such identifiable factors like sex, month, year of calving and sire, information about the heritabilities of the phenotypic and genetic correlations among the measures of preweaning performance are vital pre-requisites for designing a reliable genetic improvement programme for the breed.

The objective of the study reported here was to obtain estimates of these genetic and phenotypic parameters.

MATERIALS AND METHODS

Data. The data used in this investigation including the location of the farm, general management of the animals, the mating and breeding policies have been described inconsiderable detail by Adeyanju *etal.* (1976). In all, 629 data involving 14 sires each with an average of 45 progeny were analysed. *Statistical procedures.* Genetic analysis of the data was carried out based on the following paternal half-sib model: $y_{ij} = u + s_i + e_{ij}$

where y_{ij} is the $_{jth}$ observation for each trait on the $_{ith}$ sire, u is the common mean, S_i is the additive effect of the $_{ith}$ sire and e_{ij} is the uncontrolled environmental and genetic deviation attributable to individuals within sire groups.

The variance components from the analysis of variance provide parameters including heritability. The theoretical analysis of variance is presented in Table 1. 6^2_s is really ameasure of the differences among sire groups.

Since these sire groups are made up of half sibs in the present data, thesire variance component (6^2_s) is equivalent to the covariance between paternal half sibs which, in turn, estimates ¼ of the additive genetic variance among half-sibs. Thevariance component (6^2_e) estimates the remainder of the genetic variance plus all the environmental variance.

Heritability was estimated as $\frac{46^2_s}{6^2_s + 6^2_e}$

and the standard error of this estimate was calculated according to an approximate method suggested by Swiger, Harvey, Everson and Gregory (1964).

To obtain the components of covariance necessary for the computation ofthe correlations, an analysis of covariance using the procedure outlined by Kempthorne (1957) was carried out. Briefly, the basis of this procedure isthe definition of the variance of a sum which is equal to the sum of the variances of its components plus

TABLE 1

General Theoretical Analysis of Variance

Source of Variation	*D.F.*	*MS*	*EMS*
Between Sires	S — 1	MS_s	
Progeny within Sires	N — s	MS_e	

where S = number of sires

k = coefficient of expected mean squares = 44.17

n = total number of calves.

twice the covariance between such components. For this study, the usual paternal halfsib analysis of variance was run on the sets of records A and B separately andthen on a compound variable defined as A + B. By solving $6_{A,B} = \frac{1}{2} [6^2_{A+B} - 6^2_A - 6^2_B]$ the covariances between any two traits A and B were computed.

These components of variance and covariance were then used to compute the genetic, environmental and phenotypic correlations according to the general formulae given by Becker (1975).

RESULTS AND DISCUSSION

The analysis of variance for the preweaning performances is presented in Table 2. These results show that sire effects are significant (P   0.005) for all the traits investigated, namely, birth weight, preweaning weight gain and weaning weight. The variance and covariance components are given in Table 3.

Since this is probably the first attempt at a comprehensive evaluation of the Ndama cattle for preweaning performance in this ecological environment it was considered necessary and most relevant to measure the magnitude of the genetic, environmental and phenotypic variances and convariances in this particular herd of the breed. In practical terms, these statistics are useful information should it be necessary to construct a selection index for the genetic improvement of preweaning performance in the breed. These variances and covariances were estimated as: $6_{GiGj} = 4\, 6_{SiSj}$ $6_{EiEj} = 6_{eiej} - 3\, 6_{SiSj}$ $6_{PiPj} = 6_{GiGj} - 6_{EiEj}$ where 6_{GiGj}, 6_{EiEj}

TABLE 2

Analyses of variance and covariance on Preweaning Performance in Ndama Cattle[a]

Sources of Variation	*df.*	*Mean Squares*			*Mean Cross-products*		
		BW	*PWG*	*WW*	*(BW, PWG)*	*(BW, WW)*	*(PWG, WW)*
Between Sires	13	16.94***	0.03	1085.21	7.20	369.86	283.3337
Pregeny within Sires	615	6.88	0.01	277.05	6.97	313.49	279.57

[a]BW = Birth weight; PWG = Preweaning weight gain; WW = Weaning weight.

TABLE 3

Components of variance and Covariance

Source of Variation	*Components of Variance*			*Components of Covariance*		
	BW	*PWG*	*WW*	*(BW, PWG)*	*(BW, WW)*	*(PWG, WW)*
Sire	0.23	0.00	18.30	0.01	1.28	0.09
Residual	6.88	0.01	277.05	6.97	313.49	279.57

and $б_{PiPj}$ are, respectively, the genetic, environmental and phenotypic variances or covariances while $б_{sisj}$ and $б_{eiej}$ are the variance or covariance components for sires and for half-sibs respectively. If, for anyof the equations i = j, then we mean variance and if i # j we mean covariance. Estimates of the mean performance, the genetic, environmental and phenotypic variances are presented in Table 4 while the estimates of heritability phenotypic and genetic correlations are shown in Table 5.

Heritabilities:

The estimate of heritability of 0.13 obtained for birth weight in this breed is considerably lower than estimates found in the literature. For example, Warwick (1958) in an earlier review reported a range of 0.11 to 1.0 with an average value of 0.41 for the heritability of birth weight. Although it is agreed among animal breeders that estimates of certain genetic parameters including heritability are specific for the breed and environment in which they are calculated, the wide divergence between the estimate of 0.13 based on the present data and those reported by several other workers (e.g. Swiger, 1961; Shelby, Clark and Woodward, 1955; Kock and Clark 1955

TABLE 4

Mean performance and genetic environmental and phenotypic variance (along the diagonal) and caraviances (above the diagonal)

Item			*BW*	*PWG*	*WW*
Means[b] ± S.E.			19.65(kg) 0.16	0.38(kg)0.00	97.61(kg) 0.59
. Variances and Covariances:. *Traits*[a] . .					
	BW	G[c]	0.91	0.02	5.11
		E	6.20	6.95	309.66
		P	7.11	6.97	314.76
	PWG	G		0.00	0.34
		E		0.00	279.32
		P		0.01	279.66
	WW	G			73.19
		E			222.16
		P			295.34

[a]See definition in Table 2.
[b]Adapted from Adeyanju, Akinokun and Ariyibi (1976).
G = genetic; E = environmental; P = phenotypic.

TABLE 5

Estimates of heritabilities (along the diagonal), genetic correlations (above the diagonal) and phenotypic correlations (below the diagonal).

	Traits[a]		
Traits[a]	*BW*	*PWG*	*WW*
BW	0.13 ± 0.08	0.49	0.63
PWG	0.20	0.30 ± 0.14	0.89
WW	0.34	0.96	0.25 ± 0.12

[a]BW = Birth weight;
PWG = preweaning weight gain; and
WW = weaning weight.

TABLE 6
Summary of Literature on phenotypic and genetic correlations among some preweaning performance traits in beef cattle.

Traits[a]						Source
(BW, PWG)		(BW, WW)		(PWG, WW)		
r_p	r_G	r_p	r_G	r_p	r_G	
0.21	0.46	0.39	0.63	0.98	0.98	Kock and Clark (1955)
0.12	0.11	0.30	0.21	—	—	Brinks *et al.* (1962)
0.23	0.46	0.41	0.60	0.98	0.99	Brinks *et al.* (1964)
0.20[b]	0.30	0.42	0.42	1.08	0.90	Pahnish *et al.* (1964)
0.09[c]	1.98	0.31	1.12	0.94	1.70	Pahnish *et al.* (1964)
0.20	0.49	0.34	0.63	0.96	0.89	Present Data

a. See Table 2 for definitions
b. Extimates along this row were calculated from heifer data
c. Estimates along this row were calculated from steer data
r_p and r_g denote phenotypic and genetic correlations respectively.

and Brinks, Clark, Kieffer and Vrick, (1964) is somewhat surprising but not unusual. Blackwell, Kock, Shelby and Clark (1962), for instance, reported even slightly lower estimates of 0.08 and 0.11 respectively for the same trait.

For preweaning weight gain the heritability estimate of 0.03 obtained from the present Ndama data is comparable to those published by Brinks *et al* (1964), Cunningham and Henderson (1965) and Marlowe and Vogt (1965). It is, however, slightly higher than the estimates reported by Kock and Clark (1955), Swiger *et al.* (1962) and Pahnish *et al.* (1944).

The estimate of heritability of 0.25 was obtained for weaning weight. This estimate is very similar to those reported by Kock and Clark (1955) and Swiger (1961) while it is slightly higher than the estimate of 0.23 obtained by Shelby *et al.* (1955) and Pahnish *et al.* (1954). On the other hand the estimate of 0.30, 0.43 and 0.32 reported by Warwick (1958), Brinks *et al.* (1964) and Minyard and Dinkel (1965) respectively are definitely higher than the estimate based on the present Ndama data.

Over all, perhaps with the exception of birth weight these estimates of heritability suggest that considerable gentic variability exists in this population of Ndama cattle for these traits. Hence it is to be expected that moderate imporvement would be achieved if these traits are selected for. *Phenotypic and Genetic correlations.* The range of phenotypic as well as genetic correlations observed among the preweaning performance traits in this study compares favourably with estimates in the general literature on beef cattle. A tabular summary of some relevant estimates extracted from the literature is provided side by side with those found from the present data in Table 6.

On the phenotype level, birth weight in the Ndama cattle would seem to have low to moderate positive correlations with the total preweaning weight gain and weaning weight respectively whereas weaning weight and preweaning weight gain are highly correlated (r_p = 0.96). The genetic correlation between birth weight and preweaning weight gain is moderate while that between birth weight and weaning weight is high. The estimate of 0.89 for the genetic correlation between preweaning weight gain and weaning weight is somewhat lower than 0.98 and 0.99 reported respectively by Kock and Clark (1955) and Brinks *et al.* (1967). The high genetic correlation between these two traits suggests that botb are influenced by common sets of genes.

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