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Non-genetic and genetic factors influencing growth performance in Murrah Buffalos

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Abstract

Live weight data from 590 Murrah buffalo calves (140 male and 450 female calves) maintained at the Central Cattle Breeding Farm, Alamadhi, Tamil Nadu, India, born in the period between 1990 and 2004 were used for this study. Data were analysed using least-squares procedures. The adjusted birth weights of male and female calves were 33.0 ± 0.49 and 31.9 ± 0.27 kg, respectively, with an overall value of 32.4 ± 0.30 kg. The mean body weight at three, six, nine and 12 months of age pooled over periods, season and sex were 62.0 ± 0.65, 87.9 ± 0.95, 112.4 ± 1.23 and 134.16 ± 1.41 kg, respectively. Period of calving influenced the weight significantly at birth, three and six months of ages only. The effect of dam parity on body weight at different ages was highly significant. The calves born during the dam's second parity were generally heavier than those born in other parities. Generally, males had a higher body weight than females at all age groups. All the growth traits showed medium heritability (direct) estimates, which ranged between 0.12 ± 0.01 and 0.22 ± 0.16. The genetic correlations were all medium to high and positive. The genetic parameter estimates indicated that the six months weight can be used as a selection tool for genetic improvement of growth traits considering its high heritability and positive genetic correlations with succeeding growth traits.

Keywords: Body weight, heritability, genetic correlations
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Introduction

The genetic improvement of growth of Murrah buffaloes is of great importance in the large ruminant industry in India, since buffaloes contribute 19.8% of the total meat production (Report, 2006). In addition, the growth rate of a heifer calf until it matures to a cow is also an important trait because it characterises the adaptability and economic suitability of the animal. It is expected that animals growing faster in terms of body weight may also initiate physiological functioning of reproduction and milk production earlier. Reports on growth rate of Murrah buffaloes were few (Basu & Rao, 1979; Report, 1982; Patnaik, 1988; Yadav *et al*., 2001; Kumaravel *et al*., 2004) and little is known about the non-genetic factors that can interfere with body weight at different ages in Murrah buffaloes. Against this background, this study aimed to evaluate effects of various non-genetic factors on body weight of Murrah buffaloes and to estimate the genetic factors for these characteristics. The above study will help to formulate suitable evaluation procedures especially in organised farms for improving economic traits of this breed.

Materials and Methods

Growth data from 590 (140 males and 450 females) Murrah calves produced by 236 dams and 44 sires born in the period between 1990 and 2004 were collected from Central Cattle Breeding Farm, Alamadhi, Tamil Nadu. Animals were reared under intensive system of management. Regular weighing was done at birth, three, six, nine and 12 months of age. The data were subjected to least-squares analysis of variance using LSMLMW PC-2 VERSION software package (Harvey, 1990). The data were analysed to examine the effects of period, season, sex and parity on body weights at different ages. The data were analysed using a mixed model least-squares analysis for fitting constants, including all main effects and interactions. In the initial model, all interactions were found to be non-significant and hence all interactions were ignored in the final model, which was:

$$Y_{ilklm} = \mu + P_i + S_j + T_k + U_l + e_{ijklm.}$$

Where,

Y_{ijklm} = observed body weight at different ages,

μ= population mean,
P_i = effect of i^{th} period ($_i$ =1 to 3),
S_j = effect of j^{th} season ($_j$ =1 to 4),
T_k = effect of k^{th} sex ($_k$=1 and 2),
U_l = effect of l^{th} parity ($_l$=1 to 6) and
e_{ijklm} = random errors.

The DFREML programme (Meyer, 2000) was used for the estimation of (co)variance components. The fixed effects that were found to be significant (P <0.05) were incorporated into the operational models. Random terms were added to analytical models sequentially. Random effects that were significant in the single-trait analyses were included in the three-trait analysis. Three-trait analyses were then performed to estimate correlations among traits. The following single-trait animal models (in matrix notation) were fitted for each trait:

1. $Y = Xb + Z_1a + e$
2. $Y = Xb + Z_1a + Z_2m + e$ with cov (a,m) = 0
3. $Y = Xb + Z_1a + Z_2m + Z_3c + e$ with cov (a,m) = 0

Where:
Y = the vector of observations for growth traits
b = the vector of fixed effects
a = the vector of direct genetic effects
m = the vector of maternal genetic variances
c = the vector of maternal permanent environmental variances
e = the vector of residuals

X, Z_1, Z_2 and Z_3 are the corresponding incidence matrices relating the respective effects to y.
It was assumed that: $V(a) = A\sigma^2_a$; $V(m) = A\sigma^2_m$; $V(c) = A\sigma^2_c$ and $V(e) = I\sigma^2_e$

Results and Discussion

Selection of an appropriate model was done according to log likelihood values. Log likelihoods obtained for each trait under the different models of analyses with the most appropriate model in bold are presented in Table 1. The most appropriate model for all the traits was those with direct additive, maternal and permanent environmental effects due to dam.

Table 1 Log likelihoods obtained for growth traits with the best model in bold

Model	(co) Variance components	Birth	3 months	6 months	9 months	12 months
1	h^2	-1432.54	-18756.05	-19876.25	-18987.12	-19987.58
2	$h^2 + m^2$	-1123.42	-17586.02	-18546.02	-17689.14	-18249.12
3	$h^2 + m^2 + c^2$	**-946.23**	**-12456.31**	**-14243.03**	**-13125.38**	**-15243.03**

h^2 = Direct additive, m^2 = Maternal additive and c^2 = permanent.

The least-squares mean estimates (± s.e.) of weight at birth, three, six and 12 months of age were 32.4 ± 0.30, 62.0 ± 0.65, 87.9 ± 0.95 and 134.2 ± 1.41 kg, respectively (Table 2) and the mean growth rate from birth to three, birth to six and birth to 12 months of age were 32.9 ± 1.62 , 30.78 ± 1.51 and 27.9 ± 0.98 g/day respectively. The overall growth rate of males (28.5 ± 0.75 g/day) was slightly higher than females (27.3 ± 0.89 g/day). The birth weight observed in the present study was higher than those reported by Veerapandian *et al*. (1996), Yadav *et al*. (2001) and Kumaravel *et al*. (2004) on the same breed. However, comparable values were also found by Basu & Rao (1979), Patnaik (1988) and Kumar *et al*. (2007) on Murrah calves.

The body weight observed at different ages were comparable to the values already reported by Patnaik (1988) on the same herd. The body weight up to three months of ages reported by Basu & Rao (1979), Report (1982) and Kumar *et al*. (2007) were also comparable to the present estimates, however they reported higher weights at six, nine and 12 months of age. The lower value observed in the present study compared to

Table 2 Least-squares means (± s.e.) for body weight (kg) of Murrah buffaloes at different ages

Effect	n	Birth weight	3 months	6 months	9 months	12 months
Overall mean	590	32.4 ± 0.30	62.0 ± 0.65	87.9 ± 0.95	112.4 ± 1.23	134.2 ± 1.41
Period		**	*	*		
Period 1 (1990-1994)	251	33.3^{b} ± 0.35	60.0^{a} ± 0.76	86.3^{a} ± 1.10	110.8 ± 1.43	130.7 ± 1.64
Period 2 (1995-1999)	184	31.7^{a} ± 0.46	62.9^{b} ± 0.99	87.8^{b} ± 1.45	111.7 ± 1.88	134.3 ± 2.16
Period 3 (2000-2004)	155	32.3^{a} ± 0.49	63.1^{b} ± 1.06	89.6^{c} ± 1.57	114.6 ± 2.02	137.5 ± 2.33
Season						
Winter	125	32.2 ± 0.49	61.2 ± 1.07	86.2 ± 1.57	109.0 ± 2.03	130.6 ± 2.34
Summer	56	32.5 ± 0.70	61.3 ± 1.54	87.9 ± 2.26	112.6 ± 2.92	135.0 ± 3.36
South-west monsoon	202	32.8 ± 0.41	61.9 ± 0.89	87.4 ± 1.30	112.2 ± 1.68	133.5 ± 1.94
North-east monsoon	207	32.3 ± 0.38	63.5 ± 0.83	90.1 ± 1.22	115.7 ± 1.58	137.6 ± 1.81
Sex		*	**			*
Male	140	33.0^{b} ± 0.49	64.5^{b} ± 1.08	89.4 ± 1.58	113.5 ± 2.05	136.9^{b} ± 2.35
Female	450	31.9^{a} ± 0.27	59.5^{a} ± 0.58	86.4 ± 0.85	111.2 ± 1.11	131.4^{a} ± 1.27
Parity		**	**	**	**	**
First	137	30.1^{a} ± 0 .48	53.1^{a} ± 1.04	76.6^{a} ± 1.52	99.3^{a} ± 1.97	119.4^{a} ± 2.27
Second	122	32.5^{b} ± 0.53	63.9^{cf} ± 1.16	90.9^{c} ± 1.71	116.5^{d} ± 2.21	139.4^{d} ± 2.54
Third	111	32.4^{b} ± 0.52	62.4^{bf} ± 1.12	87.9^{b} ± 1.65	112.2^{b} ± 2.13	134.9^{b} ± 2.45
Fourth	74	33.7^{cd} ± 0.61	64.8^{d} ± 1.34	91.0^{c} ± 1.97	115.7^{d} ± 2.54	134.5^{b} ± 2.92
Fifth	57	32.9^{bd} ± 0.69	63.6^{ce} ± 1.51	90.3^{c} ± 2.22	114.7^{c} ± 2.87	137.5^{c} ± 3.30
Sixth and above	89	33.1^{cd} ± 0.57	64.2^{de} ± 1.25	90.7^{c} ± 1.83	115.9^{d} ± 2.37	139.0^{d} ± 2.72

* P <0.05 ** P <0.01 Means bearing same superscript do not differ significantly (P >0.05).

reports from north India might be due to genotype x environment interaction. The climatic conditions of Murrah buffaloes in its breeding tract are generally hot, semi-arid and dry in nature; whereas the climatic condition in southern coastal region is hot, semi-arid and humid in nature. The high humidity and temperature of southern peninsular coastal region of Tamil Nadu are perhaps the reason for the lower body weight of Murrah breed in this region. However, this needs further detailed investigation.

The period of birth had significant to highly significant (P <0.01) effect on birth, three and six months of ages and this might be due to variation in management practices and availability of quality fodder over the periods. It is in accordance with the report of Yadav *et al.* (2001). Season of birth had no significant (P >0.05) effect on body weight at different ages and is similar to the report of Yadav *et al* (2001). On the contrary, Basu & Rao (1979), Report (1982) and Kumaravel *et al.* (2004) observed significant effect of season of birth on body weight at different ages. The influence of sex of the calf was found to be significant on weight at birth and 12 months of age and highly significant effect on weaning weight. Males were heavier at all ages than the females. The increase in body weight probably arises from the increasing differences in the endocrine system between males and females (Swenson and Reece, 1993). Significant influence of the sex of the calf on birth weight was also reported by Basu & Rao (1979), Report (1982) and Kumaravel *et al.* (2004). Parity had highly significant effect on all the traits studied. The body weight observed in first parity (Figure 1) was significantly lower than those observed in later parities.

The direct heritability estimates for birth, three, six, nine and 12 months of age were 0.12 ± 0.01, 0.19 ± 0.02, 0.22 ± 0.06, 0.18 ± 0.08 and 0.20 ± 0.06 respectively and the maternal heritability estimates were 0.11 ± 0.02, 0.09 ± 0.02, 0.08 ± 0.03, 0.05 ± 0.01 and 0.08 ± 0.03, respectively (Figure 2). The maternal permanent environmental variances observed at birth, three, six, nine and 12 months of age 0.041 ± 0.013, 0.032 ± 0.014, 0.030 ± 0.013, 0.014 ± 0.009 and 0.028 ± 0.016, respectively. The increasing heritability of body weights at the later stages of developmental process indicates that environmental factors had more influence on birth weight than on the weights achieved later in developmental stages. The heritability of birth weight observed was lower than the findings of Report (1982) and Yadav *et al.* (2001) and Salces *et al.* (2006). The estimates of correlation between body weight at different ages are given in Table 3.

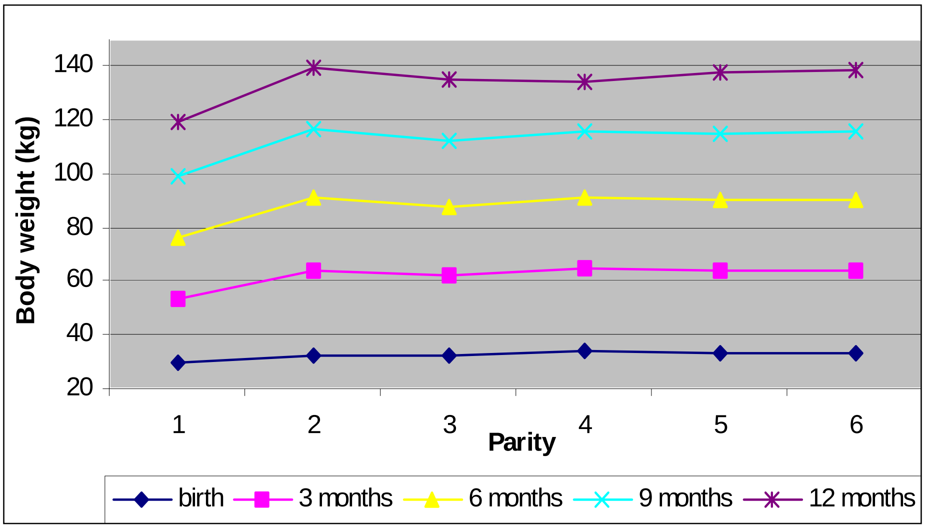

Figure 1 Effect of parity on body weight at different ages

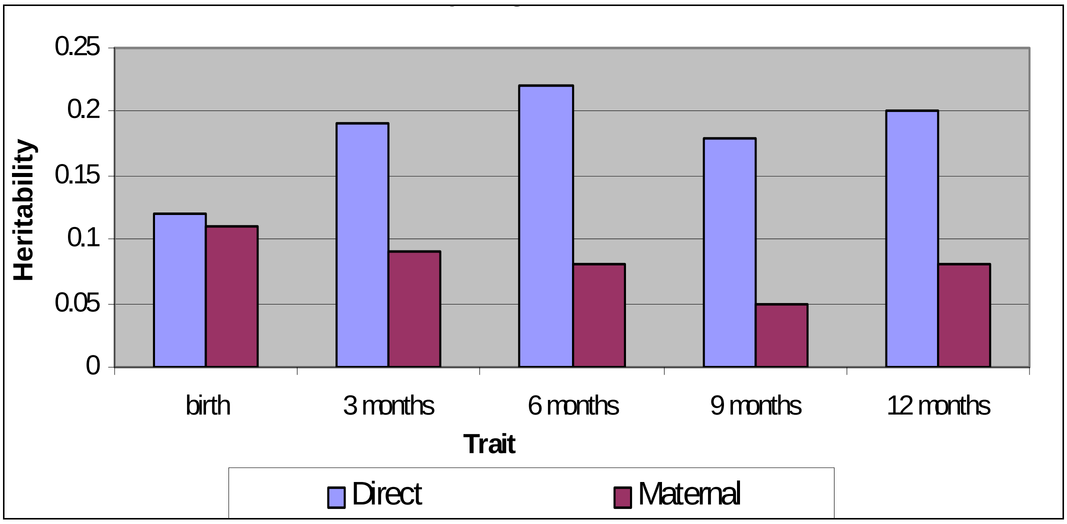

Figure 2 Effect of increase in age on additive direct and maternal effects on body weight of Murrah calves

The estimates of genetic correlation between birth weight and weight at different ages were medium to high and positive and it is in accordance with the previous reports on Murrah buffaloes (Report, 1982; Salces *et al*., 2006). The genetic correlations between body weight at different ages were positive and medium to high in magnitude. The moderately high genetic correlations between birth weight and the weight at six and nine months in this study indicate that selection for increased birth weight would also result in genetic improvement in the subsequent ages. Although the birth weight may be suitable criteria in a preliminary section for growth, the strong maternal influences must not be ignored, as it tends to mask the true genetic merit in the calves. The results of this study indicated that selection for weight should be done on the basis of six months or nine months weight. A positive response should be expected in other traits owing to the generally large and positive correlations.

Conclusions

The study revealed that the non-genetic factors such as period of birth, sex of the calf and parity of the dam might be considered when performing an evaluation of Murrah calves based on growth traits. The effect of parity on the production performances has been demonstrated for the commercial exploitation of this

Table 3 Estimates of genetic and phenotypic correlations between body weight at different ages of Murrah buffaloes

Traits	Genetic correlation	Phenotypic correlation	Environmental correlation
Birth weight with Three months weight	0.721 ± 0.124	0.518 ± 0.103	0.42 ± 0.02
Six months weight	0.704 ± 0.134	0.425 ± 0.127	0.29 ± 0.05
Nine months weight	0.685 ± 0.128	0.310 ± 0.101	0.22 ± 0.03
Twelve months weight	0.524 ± 0.118	0.280 ± 0.098	0.12 ± 0.04
Three months weight with Six months weight	0.687 ± 0.245	0.841 ± 0.245	0.38 ± 0.04
Nine months weight	0.586 ± 0.202	0.824 ± 0.223	0.26 ± 0.03
Twelve months weight	0.508 ± 0.211	0.810 ± 0.247	0.18 ± 0.02
Six months weight with Nine months weight	0.786 ± 0.239	0.854 ± 0.211	0.41 ± 0.03
Twelve months weight	0.657 ± 0.215	0.812 ± 0.325	0.28 ± 0.01
Nine months weight with Twelve months weight	0.796 ± 0.226	0.869 ± 0.198	0.39 ± 0.04

breed for meat purpose. Estimated heritability for six months weight and its genetic correlations with body weight at other ages were high, suggesting that improvement in genetic gains for body weight could be reached by using this trait in selection programmes. Further estimation of genetic parameters based on large amounts of data on various economically important traits (i.e. growth efficiency traits along with body weights at different ages) will help in accurate selection of animals to improve the genetic capacity of the breed for meat production.

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