RESTRICTED MAXIMUM LIKELIHOOD ANIMAL MODEL ESTIMATES OF HERITABILITY FOR VARIOUS GROWTH TRAITS AND BODY MEASUREMENTS OF SWAMP BUFFALOES

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The data about pedigree, growth and body measurements of 1736 Swamp buffalo calves collected during 1980 to 1991 from Surin Livestock Breeding and Research Station, Thailand were utilized for the computation of heritability estimates for various growth traits and body measurements. Restricted maximum likelihood procedure fitting an individual animal model was followed throughout. Various environmental factors observed to be significant sources of variation for various growth traits and body measurements were fitted as fixed effects in the model of analysis. This included sex, year and season of birth and parity for birth weight; year and season of birth and parity for weaning weight; year and season of birth for 2-year weight; sex, year and season of birth and parity for preweaning average daily gain and year and season of birth and parity for postweaning average daily gain. As regards the fixed effects for the analysis of body measurements sex, year of birth and parity were fitted for all the body measurements. Season of birth was fitted only for heart girth at birth, height at birth and at weaning. The heritability estimates were 0.66 ± 0.07, 0.86 ± 0.08 and 0.34 ± 0.13 for birth weight, weaning weight and 2-year weight respectively. The heritability values were 0.83 ± 0.07 and 0.32 ± 0.12 for preweaning average daily gain andpostweaning average daily gain respectively. The corresponding values for body length, heart girth and height at birth were 0.16 ± 0.06, 0.61 ± 0.07 and 0.61 ± 0.08 respectively. The heritability estimates for height at weaning and height at 2 years were 0.71 ± 0.10 and 0.47 ± 0.14 respectively. The moderate to high estimates of heritability for various growth traits and most of the body measurements of Swamp buffaloes indicated that additive gene action is important for these traits and non-additive genetic effects and environmental effects are of minor importance. It implies that there are good prospects of improvement in these performance traits through selection.

Key words: Heritability estimates, growth traits, body measurements, swamp buffaloes

INTRODUCTION

Accurate estimates of genetic parameters Le. heritability of different performance traits and the genetic correlations among them are needed for the estimation of breeding values of animals using the best linear unbiased prediction procedure. Chantalakhana et al. (1981, 1984) and Topanurak (1991) computed heritability estimates of some growth traits and body measurements of Swamp buffaloes in Thailand but the methodology then used is outdated now. There are arguments (e.g. Thompson, 1973) that suggest that restricted maximum likelihood procedure can provide unbiased estimates of genetic parameters in populations under selection and with culling of animals on the basis of early body weights. The present study was thus planned to estimate heritability values for various growth traits and body measurements of Swamp buffaloes using restricted maximum likelihood procedure fitting an individual animal model.

MATERIALS AND METHODS

Data about predigree, growth and body measurements (1980-1991) of 1736 Swamp buffalo calves collected from Surin Livestock Breeding and Research Station, Thailand were utilized for the estimation of heritability for birth weight (kg), weaning weight (kg, adjusted to 240 days of age), 2 year weight (kg), preweaning average daily gain (g) postweaning average daily gain (expressed in grams, upto to 2 years of age), body length at birth (cm), heart girth at birth (cm), height at birth (cm), height at weaning (cm) and height at 2 years (cm). Weaning weight of calves were recorded at a mean age of 240 days (range from 180 to 300 days). Adjusted 240-day weaning weight was calculated as (growth rate from birth to weaning x 240) + birth weight. The data were checked for unrealistic entries and outliers. For this purpose records outside ±3 standard deviations from the phenotypic mean of the respective trait were taken out. The number of records eliminated during this editing was less than 2.5% of the total number of records.

The heritability values were estimated by using restricted maximum likelihood procedure as proposed by Patterson and Thompson (l971) fitting an individual animal model. The Deriative-free restricted maximum likelihood (DFREML) set of computer programmes (Meyer, 1997) was used for the analysis. All of the available pedigree information was included in the analysis in. an attempt to minimize the bias due to selection and non-random matings. The convergence criterion (variance of function values-2 log likelihood) was I x 10^{-8}. The various environmental factors observed to be significant sources of variation for different performance traits were fitted as fixed effects in the following mixed model for the estimation of heritability. This included sex, year and season of birth and parity for birth weight; year and season of birth and parity for weaning weight; year and season of birth for 2-year weight; sex, year and season of birth and parity for preweaning average daily gain and year and season of birth and parity for postweaning average daily gain. As regards the fixed effects for the analysis of body measurements sex, year of birth and parity were fitted for all the body measurements. Season of birth was fitted only for heart girth at birth, height at birth and weaning. The mixed model assumed was as follows:

$$Y_{ijk} = \mu + A_i + F_j + e_{ijk}$$

where,

Y_{ijk} = Measurement of particular trait;

μ = population mean;

A_i = random additive genetic effect of ith animal with mean zero an variance σ^2_A;

F_j = fixed effects observed to be significant from the initial analysis, &

e_{ijk} = random error with mean zero and variance σ^2_E.

Phenotypic variance (σ^2_P) was defined as the sum of additive genetic variance (σ^2_A) and the residual variance (σ^2_E). The heritability was calculated as σ^2_A/σ^2_P.

RESULTS AND DISCUSSION

The heritability estimates for various growth traits and body measurements as obtained from the animal model analysis have been presented in Table 1. They have been discussed in the following under different sub-headings:

A) Growth traits

1) Birth Weight:. The estimate of heritability for birth weight as obtained in the present study was 0.66 ± 0.07 (Table 1). It was in agreement with the findings of many workers (Chantalakhana et al., 1981; Verma et al., 1989 and Velea et al., 1991) who reported the heritability estimates ranging from 0.62 to 0.67 in different breeds of buffaloes. Several other workers (Singh et al., 1984; Due et al., 1985; Al-Amin et al., 1988; Chakravarty and Rathi, 1989 and Tien and Tripathi, 1990) have, however, reported slightly lower estimates (around 0.50) of heritability for this trait in various breeds of buffaloes. The estimate of heritability for birth weight obtained by Gogoi et al. (1987) was much higher (0.88) than that of the present study. The heritability estimates ranging from O.I 1 to 0.40 have been reported by Kirmani et al. (1984), Sharma and Basu (1984), Singh and Basu (1988), Salah-ud-Din (1989), Topanurak (1991), v.mkov (1991), Alim (1991) and Ayyat et al. (1997) in various breeds of buffaloes.

A wide variation in the heritability estimate of the present study as well as reported by many other workers could be due to several factors. The heritability for a particular trait varies between breeds, herds and even between periods of time. Inbreeding and small size of the breeding herd might reduce the genetic variation, whereas different management factors in different herds and years might increase the phenotypic variation. A high heritability estimate for birth weight in this herd indicated that larger proportion of the phenotypic variation was due to the effects of the genes and a smaller fraction was due to the environmental effects and the prospects of progress through selection within the herd appeared to be very bright. This estimate also suggested that there was less scope for improving birth weight through better feeding, management etc. Increase in birth weights beyond a certain limit results in increase in the incidence of dystocia thus causing greater economic losses but in the present herd average value for birth weight was 30 kg which was not very high as compared to the well defined beef cattle breeds like Simmental or Charolais. So selection for higher birth weights may be recommended in this herd at least on short temi basis.

2) Weaning Weight; The heritability estimate for weaning weight of the buffaloes was 0.86 ± 0.08 (Table 1). A very high estimate of heritability for weaning weight had also been reported by Kirmani et al. (1984) in graded Murrah buffaloes of India. The weaning weight records of20 1 buffaloes were analyzed by paternal half-sib correlation technique and the estimate of heritability was reported to be 0.75 ± 0.07. In the studies conducted on the Swamp buffaloes (Chantalakhana et al., 1981, 1984 and Topanurak, 1991), the heritability estimates for weaning weight were reported to be low as compared with the present study. The values of heritability ranged from 0.09 to 0.37. In case of beef cattle, however, such high estimates have been reported by Rollins and Wagnon (1956) and Cantet et al. (1988). The estimates of heritability as reported by these workers were 0.84 (grade Hereford; by regression of daughter on dam) and 0.88 (Hereford; by correlation between full sibs). However, the results of the present study suggested that the observed variation in weaning weight of the buffaloes was largely due to the effects of genes and the environment appeared to have little role to play in the control of this trait.

3) 2-Year Weight:. The heritability estimate for 2-year weight was 0.34 ± 0.13 (Table I). This is in agreement with the findings ofSharma and Basu (1984) fQr NiIi buffaloes of India. The estimate of heritability for this trait was reported to be 0.31 ± 0.21.. The estimate of heritability for 2-year

weight as obtained in the present study was lower than the value (0.60) reported by Topanurak (1991) for Swamp buffaloes of Thailand. Singh et al. (1984) and Dahama and Malik (1989) also reported high estimates of heritability for 2-year weight. The estimates of heritability as reported by these workers were 0.73 ± 0.07 and 0.56 ± 0.11, respectively. Tien and Tripathi (~1990) and Vijai et al. (1993), however, reported lower estimates of heritability (0.18 ± 0.11 and 0.00, respectively) for body weight at two years as compared to the present study. The moderate estimate of heritability for body weight at two years of age suggested that most of the observed variation in the trait was due to the additive effects of the genes.

4) Preweaning Average Daily Gain: The restricted maximum likelihood animal model estimate of heritability for preweaning average daily gain was 0.83 ± 0.07 (Table 1). This is higher than the estimates reported by Chantalakhana et al. (1984) and Topanurak (1991) for the Swamp buffaloes. The values of heritability for preweaning average daily gain reported in the two studies were similar (0.06). This estimate of heritability for preweaning average daily gain was similar to the value obtained for weaning weight. The moderate estimate of heritability for preweaning average daily gain as obtained in the present study suggested that the trait was under the influence of genes and preweaning average daily gain may be improved through selection.

5) Postweaning Average Daily Gain: The estimate of heritability for postweaning average daily gain to 2 years of age was 0.32 ± 0.12 (Table 1). The estimate of heritability for postweaning average daily gain as obtained in the present study was lower than the estimates of heritability reported by Chantalakhana et al. (1984) and Topanurak (1991) for the Swamp buffaloes. The estimates as reported in these two studies were 0.52 and 0.75 respectively. The moderate estimate of heritability for postweaning average daily gain to 2 years of age as obtained in the present study suggested that the trait was under the influence of genes and postweaning average daily gain may be improved through selection.

B) Body Measurements: The heritability estimates for body length, height and heart girth at birth were 0.16 ± 0.06, 0.61 ± 0.07 and 0.61 ± 0.07 respectively (Table 1). As regards the heritability estimates for these body measurements, the study conducted by Chantalakhana et al. (1984) appears to be the most relevant one. The estimate of heritability for body length at birth was reported to be 0.16 which is very close to the estimate obtained in the present study. However, for height at birth and heart girth at birth, lower estimates of heritability were reported by Chantalakhana et al. (1984) than those obtained from the present study. The estimates of heritability as reported by them were 0.15 ± 0.11 for height at birth and 0.10 ± 0.09 for heart girth at birth.

The estimate of heritability for height at weaning was 0.71 ± 0.10 (Table 1). This is very high as compared to the estimate (0.07) obtained by Chantalakhana et al. (1984) for the Swamp buffaloes. The estimate of heritability of height at 2 years of age was 0,47 ± 0.14 (Table 1). Further information in this respect is not readily available here.

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Table I. Heritability estimates for various growth traits and body measurements of swamp buffaloes

Trait	No. of sires with progeny records	No. of records	No. of animals in pedigree	Heritability estimate ±S.E.
Growth Traits				
Birth weight (kg)	29	1736	2133	0.66±0.07
Weaning weight (kg)	29	1374	1728	0.86± 0.08
2-yearweight (kg)	23	412	544	0.34± 0,13
Preweaning avg. daily gain (g)	29	1374	1728	0.83±0.07
Postweaning avg. daily gain (g)	23	412	544	0.32±0.12
Body Measurements				
Body length at birth (cm)	29	1736	2133	0.16±0.06
Heart girth at birth (cm)	29	1736	2133	0.61±0.07
Height at birth (an)	29	1736	2133	0.61±0.08
Height at weaning (cm)	29	1054	1728	0.7i±0.10
Height at 2 years (an)	23	412	544	0.47±0.14

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