AGE-DEPENDENT CHANGES IN ESTIMATES OF GENETIC PARAMETERS FOR WEIGHTS OF HEREFORD CATTLE

Karin Meyer

Animal Genetics and Breeding Unit[1], University of New England, Armidale, NSW 2351

SUMMARY
Univariate analyses of weights of Hereford cattle from 80 to 700 days of age are presented for successive, overlapping data sets at 10- or 20-day intervals, spanning 45 days each. Estimates of heritabilities and maternal effects changed markedly with age, not only between ages assumed to represent different traits, weaning, yearling and final weight, respectively, but also within the range of ages allowed for each trait. Maternal heritabilities showed a distinct peak between 180 and 220 days, ranging from 11 to 13%, and declined steadily with age from then onwards, while maternal environmental effects explained 20 to 25% of variation of weight up to 300 days. Implications for genetic evaluation for maternal effects ("milk") are considered.
Keywords: Beef cattle, genetic parameters, changes with age, maternal effects.

INTRODUCTION
Current genetic evaluation schemes for growth of beef cattle allow a wide range of ages for individual traits. For instance, BREEDPLAN considers weights recorded between 80 and 300 days as weaning weights, and permits ranges of 200 days for yearling and final weights. Whilst differences in age at recording are taken into account - adjusting records to a common age - this practice assumes constant heritabilities over the range of ages assumed. Recent results from a series of univariate analyses of weights of Brazilian Nelore calves, from birth to about 20 months of age, showed distinct changes in estimates of genetic parameters with age (Albuquerque and Meyer 2001), especially for ages regarded as weaning weights. In particular, direct heritabilities were lowest and maternal heritabilities were highest from 180 to 210 days of age, suggesting that weights recorded at these ages were most informative for the estimation of maternal genetic or "milk" breeding values.

Similarly, random regression analyses of monthly weights of Polled Hereford calves till weaning found maternal heritabilities to be highest around 180 days (Meyer 2001). However, results were based on records from an experimental herd (Wokalup selection experiment in Western Australia) comprising about 300 cows only, subject to extreme seasonal fluctuations in availability of feed and with a strong association between age of calves and dates of weighing. Hence it was uncertain whether such pattern would hold in general. This study attempts to identify changes in genetic parameters with age of calf for field data on Hereford and Polled Hereford cattle.

MATERIAL AND METHODS
Data. Data consisted of weight records of Australian and New Zealand Hereford and Polled

[1]AGBU is a joint Institute of NSW Agriculture and the University of New England

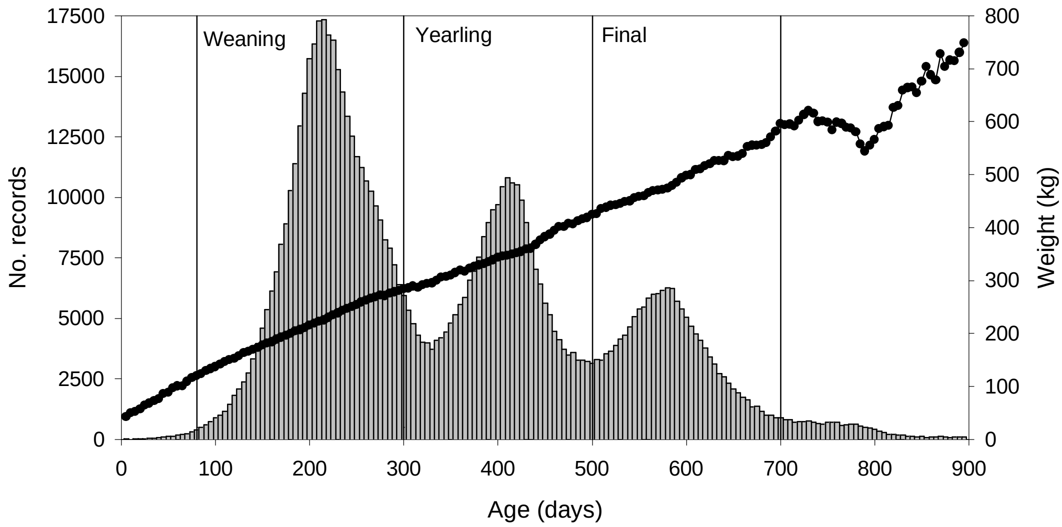

Figure 1. Distribution of numbers of records (bars) and mean weights (●) for ages at recording (in 5 day intervals).

Hereford cattle extracted from the National Beef Recording Scheme database. After edits, there were a total of 947,960 records on 435,579 animals. Figure 1 shows the distribution of weights according to age at recording (birth weights and records at more than 900 days of age not shown), together with corresponding means. Successive, overlapping subsets of the data were extracted at 10-day intervals from 80 to 400 days and 20-day intervals from 420 to 700 days of age. Each data set included weights 22 days either side of the target weight, i.e. spanned a total of 45 days (58–102 days for 80 days, … , 618–662 days for 640 days). For ages with many records, only data from the largest herds were used. The minimum number of records per herd was varied, aiming at selecting data sets with 25,000 to 35,000 records but involving at least 20 herds. All records in single record contemporary groups were eliminated. For ages greater than 110 days a minimum subclass size of 3 was required. Additional pedigree information up to two generations back (identifying parents of parents and of grandparents) was obtained for each data set. Due to the narrow age range in each analysis, only a small proportion of dams had more than one calf with a record in the given range. Similarly, few parents had weights recorded at the same age as their offspring, resulting in a large number of parents without records. Figure 2 shows the number of records for each data set together with the average number of records per dam and the number of animals in the analysis as a multiple of the number of records.

Analyses. A total of 47 univariate analyses was carried out, estimating variance components and genetic parameters by REML. The model of analysis fitted contemporary groups, defined as herd-date of weighing-management group-sex subclasses, birth type (single vs twin) and the so-called "heifer factor" (age of dam status : heifer (≤ 28 months) vs cow (> 28 months)) as fixed effects. In addition, age of dam (in years) was fitted as a linear and quadratic covariable, and a linear regression on age of weighing was fitted separately for each sex of animal. Random effects were animals' direct,

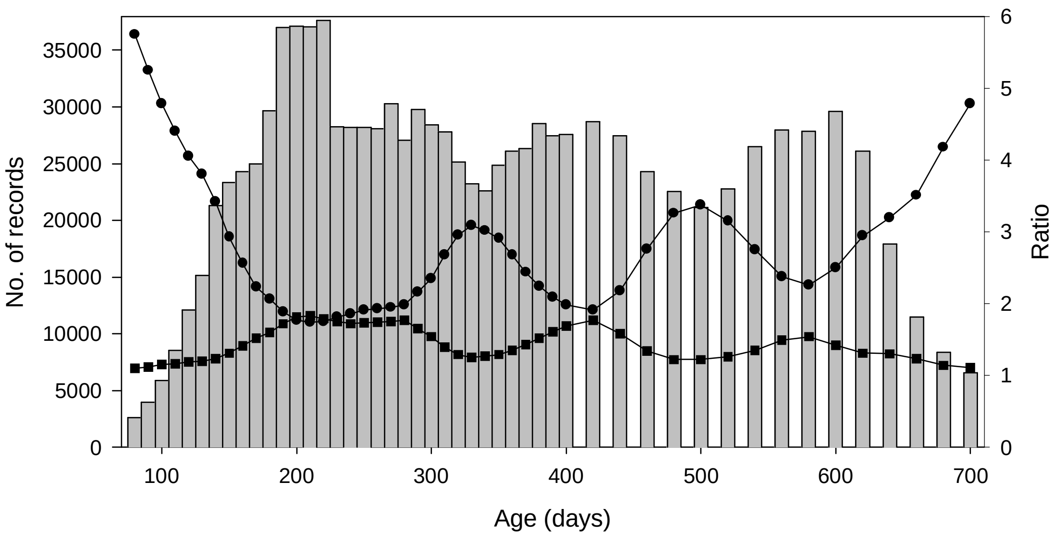

Figure 2. Number of records (bars) together with average number of progeny per dam (■) and number of animals in the analysis (including parents without records, ●, expressed as a multiple of the number of records).

additive genetic effects, maternal additive genetic effects and permanent environmental maternal effects. Direct-maternal genetic covariances were assumed to be zero.

RESULTS

Figure 3 shows estimates of phenotypic variances and genetic parameters for individual analyses. Variances increased steadily with age, but showed some fluctuations, mainly at the ages with comparatively small numbers of records (around 330, 500 and 700 days). Presumably this was an artefact of selecting different subsets of herds for different analyses. With substantially overlapping data sets, especially for analyses 10 days apart, there were few dramatic changes in estimates of genetic parameters for ages with large numbers of records available. Some small `jumps' occurred but were presumably again due to selection of different sets of herds in adjacent data sets. Analyses before 140 days and after 660 days involved small numbers of records, many animals in the analysis without records and few dams with more than one calf (see Figure 2). Hence, corresponding estimates were only of limited value - as the data clearly did not supply enough information to separate genetic and environmental components accurately.

Direct heritability (h^2) estimates from 140 to 300 days ranged from 14% to 17%, with most estimates close to 15%. After weaning, h^2 estimates increased to 21% to 25% for 300-500 days (the range allowed for yearling weight) and 27% or more subsequently (final weight; highest estimate of 40% for 700 days not shown). Maternal heritability (m^2) estimates showed a distinct peak between 180 and 220 days of age, ranging from 11% to 13%. Estimates for m^2 declined steadily from then on, indicating that weights of calves weaned at more than 220 days provided less information on their dams' maternal genetic ability than those weaned around the target age of 200 days. Estimates of permanent environmental maternal effects (c^2) were high until 300 days of age, ranging from 20% to 25% (ignoring estimates before 140 days). After weaning, c^2 values plummeted to about 10% (data sets for 310 and 320 days still contained some weaning weights) and then decreased gradually with age, similar to estimates for m^2.

CONCLUSIONS

Genetic evaluation of beef cattle should account for changes in heritability of maternal genetic effects. Records on calves weighed - though not necessarily weaned - around 200 days of age provide most information on their dams' maternal genetic ability ("milk").

REFERENCES

Albuquerque, L.G. and Meyer, K. (2001) *J. Anim. Breed. Genet.* **118** : 83.
Meyer, K. (2001) *Genet. Sel. Evol.* (in press).

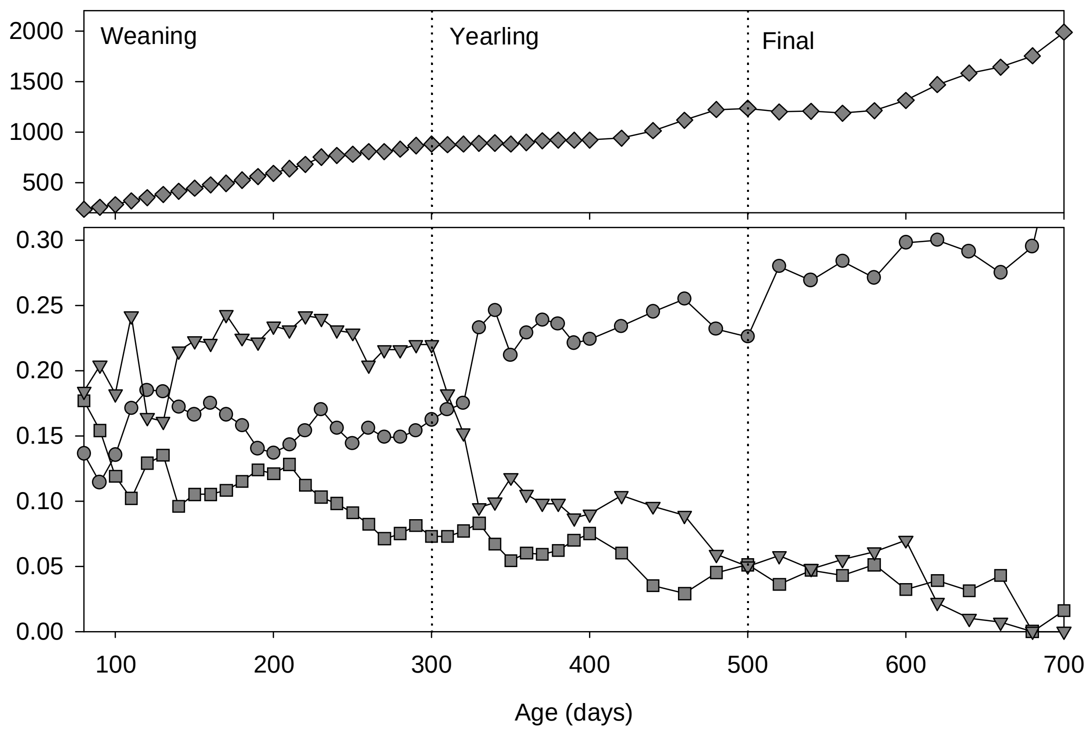

Figure 3. Estimates of phenotypic variances (◆, in kg^2), direct (●) and maternal (■) heritabilities, and maternal, permanent environmental effects (▼).