GENETIC PARAMETERS OF GROWTH CURVE IN CHICKENS

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INTRODUCTION

Genetic evaluation of chickens is based on body weight at slaughter age. This selection has resulted in evolution of the whole growth curve from embryo to adult (Timon and Eisen, 1969). Including growth curve in selection could allow to alleviate undesirable changes due to selection on juvenile body weight, especially in adult body weight. Growth curves have thus been widely used in chicken, particularly the Gompertz curve (Mignon-Grasteau and Beaumont, 2000). Moreover, selection experiments have shown that selecting on the form of the growth curve was feasible (Johnson and Gowe, 1962 ; Ricard, 1975). However, little is known about the genetics of the growth curve parameters (Grossmann and Bohren, 1985 ; Barbato, 1991 ; Mignon-Grasteau *et al*., 1999). These studies have been realised on layer type chickens, commercial broilers or experimental lines, but, to our knowledge, no estimate was available on commercial meat-type lines of chickens for extensive breeding. Our aim was thus to provide genetic parameters of the growth curve parameters on a slow growing commercial line of chickens .

MATERIALS AND METHODS

A total of 464 chickens from a slow growing meat-type line were weighed every two weeks from 4 to 16 weeks. Individual growth curves were fitted, using the Laird *et al.* (1965) form of the Gompertz function:

$$BW_t = A\ e^{(L/K)e^{-Kt}}$$

where BW_t was body weight at age t, A the asymptotic body weight (i.e., at an infinite age), L the initial specific growth rate and K the maturation rate. Age at inflection (TI), at which growth rate is maximum, was computed as $[1/K \times \ln |L/K|]$.

Parameters of the growth curve were estimated with a weighted non linear regression. Observations were weighted by the inverse of the variance of the trait at each age, as suggested by Pasternak and Shalev (1994).

Genetic parameters of the parameters of the growth curve were then estimated with a REML, using the following model:

$$\mathbf{y=Xb + Zu + e}$$

where **y** was the vector of performances, i.e. (**A, L, K, TI**)', **b** the vector of fixed effects of hatch, **u** the vector of genetic effects (10802 levels, as genealogy over 7 generations was included), **e** the vector of residuals. **X** and **Z** were the incidence matrices pertaining to **b** and **u**, respectively.

RESULTS

The Gompertz curve fitted well our data, as shown in figure 1 (R^2=0.99), the greatest difference being an overestimation of body weight at 10 weeks (3.6% in males and 2.8% in females).

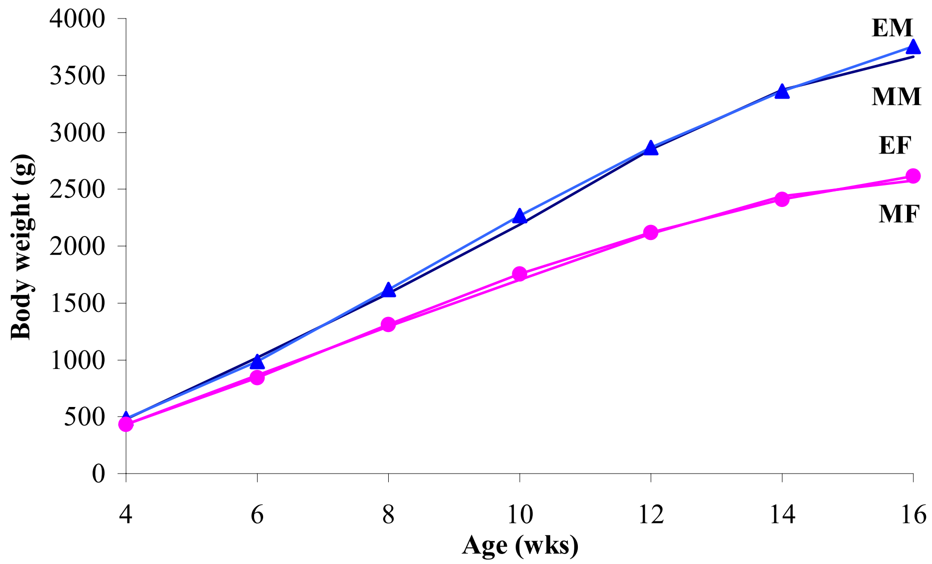

Figure 1. Mean measured growth curve in males (MM), in females (MF) and estimated growth curves in males (EM) and in females (EF)

The estimated parameters of the growth curve in both sexes are shown in table 1. They were in agreement with mean values published in the review of Mignon-Grasteau and Beaumont (2000), i.e. 0.132 d^{-1} for L, 0.029d^{-1} for K and 55 d. for TI. They were also rather close to values of Rémignon (1993), which estimated growth curve parameters in a slow growing experimental line.

Table 1. Elementary statistics (Mean$\pm$SD) on growth curve parameters

	Average	Males	Females
L (d^{-1})	0.1322$\pm$0.0210	0.1301$\pm$0.0208	0.1345$\pm$0.0211
K (d^{-1})	0.0282$\pm$0.0033	0.0268$\pm$0.0030	0.0298$\pm$0.0029
TI (d)	55.1$\pm$6.6	59.3$\pm$5.8	50.7$\pm$3.9
A (g)	3951$\pm$990	4779$\pm$601	3073$\pm$367

Estimates of growth curve parameters of male and female differed significantly (P<0.03). Differences observed between both sexes were consistent with a greater precocity of females, males showing a higher age at inflection and a lower maturation rate, as in Barbato (1991) and Mignon-Grasteau *et al*. (1999). The high difference in TI (8.6 d.) could also be related to the type of chickens used. In fact, sexual dimorphism of TI was found to be higher in slow growing lines than in fast growing lines (Knizetova *et al*. 1985; Barbato, 1991). Surprisingly, the initial specific growth rate was higher in females than in males. It may be due to the fact that at the first measured age (4 weeks), females were already in the linear part of the growth curve, and that it might be more difficult to estimate their initial specific growth rate than for males, which still were in the first phase of the growth curve at this age.

Genetic parameters of the growth curve parameters are reported in Table 2.

Table 2. Genetic parameters of the parameters of the growth curve[A]

	L	K	TI	A
L	**0.24**	0.91	-0.68	-0.30
K		**0.26**	-0.92	-0.54
TI			**0.30**	0.71
A				**0.31**

[A] Heritabilities on the diagonal, genetic correlations above the diagonal.

Heritabilities of each parameter were moderate, slightly lower than in Grossmann and Bohren (1985), Barbato (1991) and Mignon-Grasteau *et al*. (1999), but large enough to envisage selection on the shape of the growth curve. However, the growth curve being quite linear between 6 and 12 weeks, it would be equivalent to select on body weight at 8 weeks, which is more highly heritable (0.54).

K, L, and TI were highly genetically correlated. The highly negative correlation between TI and K could be deduced from the formula linking both parameters. The negative value of the estimated correlation between L and TI was probably due to the very high correlation between L and K. The genetic correlation between L and A was moderate, as expected, because L and A described the beginning and the end of the growth curve, respectively. The correlation between K and A was higher, which reflects the fact that K characterised the second part of the growth curve. The latter was expected to be negative, as $e^{1/K}$ appears in the formula of A. Finally, the high correlation between A and TI can be explained by the fact that A is equal to the body weight at inflection multiplied by "e". This was in agreement with what Mignon-Grasteau *et al*. (1999) found in lines of chickens selected on the form of the growth curve.

CONCLUSION

This study confirmed that males and females chickens can be distinguished by their growth curve parameters, females being more precocious than males. Genetic parameters of the Gompertz function parameters showed moderate heritabilities, making it possible to select directly on the form of the growth curve.

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