

Genetic parameters estimates to Gompertz growth curve parameters fitted to partridges (*Rhynchotus rufescens*) raised in captivity

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Abstract: The knowledge of the growth curve in poultry science is very useful for setting commercial strains bases, defining ages and/or weights for selection and setting management procedures. *Rhynchotus rufescens* is spread out in South America showing a limited breeding season (September to March). The adult bird reaches around 37 cm of height, 700 g of weight with the breast muscles representing 28.6 to 32.8% of the total body weight. The species seems to be a feasible commercial option for poultry industry. This research aimed to fit the growth curve Gompertz (GGC) to weight from birth to 290 days of partridges and to estimate heritabilities to the a and k parameters as well as their genetic correlation. Records came from 392 animals born from 2000 to 2004 and weighted weekly totaling 7716 observations. The growth curve parameters were estimated using a non linear procedure by the Gauss-Newton method. The convergence criterion was $10 \exp^{-9}$. The (co)variance components, heritabilities and genetic correlation estimates for the GGC parameters a (asymptotic weigh) and k (daily growth rate) were performed using a bi-trait animal model analysis processed by the restricted maximum likelihood method. The model considered the genetic additive direct effect of the animal as random and the effects of group of birth, sex, egg axis and the value of the b parameter of the curve (linear). The estimates of the Gompertz function were 676.3 ± 1.9721 , 3.1099 ± 0.0284 and 0.0235 ± 0.0002 , respectively, to a representing the mature weight, b that shows no biological meaning and k that estimates the daily rate of growth. The Gompertz model fitted very well weights of partridges ($R^2=0.90$). The heritability estimates to the traits a and k were 0.22 and 0.12, respectively and the genetic correlation between them was -0.60. These values indicated that selection could be applied to change the shape of the growth curve and also, selection to improve growth rate would result in light adult birds.

Key words: Asymptotic weight; genetic correlation; heritability; Tinamous; wild bird.

Introduction

Despite being a wild bird, initial studies (Moro, 1996) have shown the possibility of raising partridges (*Rhynchotus rufescens*) in captivity; however, it has a limited breeding season (September to March). The adult bird reaches around 37 cm of height, 700 g of weight with the breast muscles representing 28.6 to 32.8% of the total body weight. The species seems to be a feasible commercial option for poultry industry.

The genetic improvement of broilers is a tool that has been used very intensive, mainly in the last 40 years. The knowledge of the growth curve in poultry science is very useful for setting commercial strains bases, defining ages and/or weights for selection and setting management procedures. Growth curve parameters are inheritable and succeeded used in selection experiments (Braccini Neto et al., 1997; Mignon-Grasteau et al., 2000). Hruby et al. (1996), Martin et al. (1994) and Hancock et al. (1995) recommend the Gompertz function to fit broilers growth due to the facility of knowing only three parameters that have biological significance. In addition, this curve is similar to the quadratic function in number of parameters; adjusting data as good as do more complicated functions.

Therefore, this research aimed to estimate genetic parameters of the Gompertz growth curve (GGC) parameters for weight from birth to 290 days of partridges (*Rhynchotus rufescens*).

Materials and methods

The information used in this paper was taken from birds of the Wild Animal Section of the Faculdade de Ciências Agrárias e Veterinárias (UNESP), at Jaboticabal, São Paulo State, Brazil. Records came from 392 animals born from 2000 to 2004 and weighted weekly totaling 7716 observation. The proportion of females per males ranged from 1:1 to 6:1. The birds were raised in reproduction wired boxes, with concreted floor, covered by a bed lid of Coast-cross (*Cynodon dactylon*) hay, whose dimensions were 1.0 x 2.0 x 2.0 m, placed inside an avian barn. The water supply and feeding were *ad libitum* with pelitized ration in tubular hods and hanging fountains.

Eggs were collected daily and identified individually for pedigree control. After 15 days of incubation at 35.5 °C and 70% of humidity, the eggs were transferred to the birth place. The newborn chicks received temporary markers and were transferred to the breeding boxes, being the maximum allotment of 20 animals per box. The sex verification was made by cloaca reversion, when the birds weighted around 250 g and they received a definitive numbered metal marker placed on the right wing when they reached around 90g of weight. The healthy management included the checking for endo and ectoparasites and the bed lid change every two months. The daily hatch procedure caused little synchronized births, originating lots of heterogeneous animals.

The growth curve parameters were estimated using a non linear procedure by the Gauss-Newton method. The convergence criterion was $10 \exp^{-9}$. Variance analyses using the least square method were firstly performed aiming to define the best models to estimate genetic parameters. The (co)variance components, heritabilities and genetic correlation estimates for the GGC parameters a (asymptotic weigh) and k (daily growth rate) were performed using a bi-trait animal model analysis processed by the restricted Maximum likelihood method using MTDFREML program (BOLDMAN et al., 1995). The model considered the genetic additive direct effect of the animal as random and the effects of group of birth, sex, egg axis and the value of the b parameter of the curve (linear). The linear model applied can be described as:

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} + \begin{bmatrix} Z_1 & 0 \\ 0 & Z_2 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} \quad \text{where:}$$

y_1 = vetor of parameter a records;
 y_2 = vetor of parameter k records;
 b_1 = vetor of fixed effects of parameter a ;
 b_2 = vetor of fixed effects of parameter k ;
 u_1 = vetor of aleatory additive genetic effects of parameter a ;
 u_2 = vetor of aleatory additive genetic effects of parameter k ;
 X_1 e X_2 = incidence matrices for b_1 , b_2 e y_1 , y_2 elements;
 Z_1 e Z_2 = incidence matrices for u_1 , u_2 e y_1 , y_2 elements;
 e_1 e e_2 = vetor de residual effects.

Results and discussion

The estimates of the Gompertz function parameters were 676.3 ± 1.9721 , 3.1099 ± 0.0284 and 0.0235 ± 0.0002 , respectively, for a representing the mature weight, b showing no biological meaning and k that estimates the daily rate of growth. This model had an excellent adjust and the predicted mean error was 0.0785. The best estimates of weight were obtained from the fourth week of age on (Figure 1).

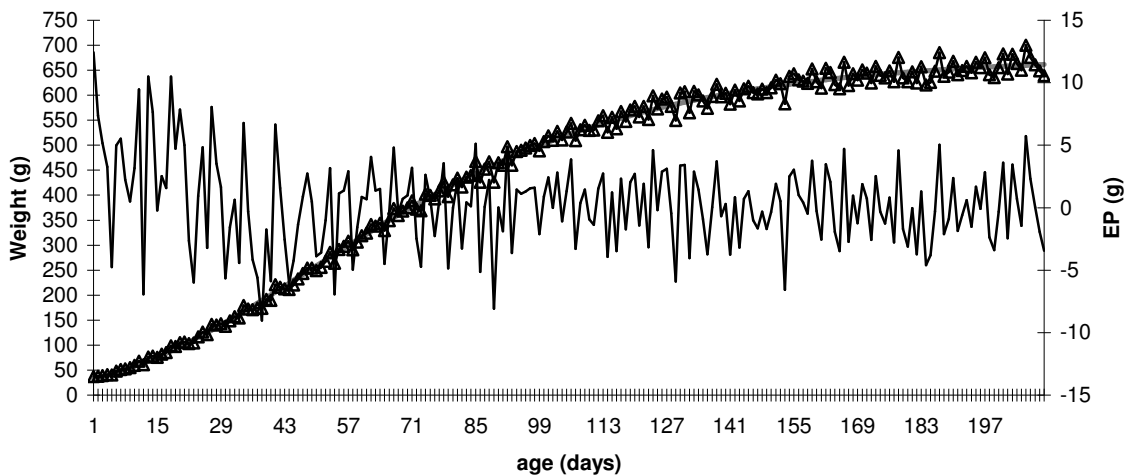


Figure 1. Estimates of predicted error (___ EP) and averages of observed (□) and adjusted (△) weight of partridges (*Rhynchotus rufescens*)

Variance analyses for a and k parameters were performed in order to check the factors affecting the studied traits. Table 1 summarizes the analyses.

Table 1. Variance analyses of parameters a (Asymptotic weight) and k (rate of maturing) of Gompertz growth curve adjusted for partridges (*Rhynchotus rufescens*).

SV	a		K	
	DF	LS	DF	LS
Group of birth	31	38116.229**	31	0.00010309**
Sex	1	134802.171**	1	0.00002318
Egg axis (L)	1	13153.754	1	0.00001970
Egg axis (Q)	1	12674.988	1	0.00001935
B	1	23436.448	1	0.00008372
Error	355	16166.707	355	0.0000 2805
	CV= 19.4369	$R^2=0.2034$	CV= 21.61451	$R^2=0.2743$

SV = Sources of variation; LS = least squares; DF = Degrees of freedom; b = b parameter of growth curve; R^2 = Coefficient of determination; CV = coefficient of variation; ** = $P < 0.01$; L = linear; Q = quadratic.

The difference between sexes showed a great importance on growth rate of birds (Table 1). Chen et al. (1987) observed differences between growth rates of males and females broilers from the sixth week of age on. According to these authors, males show higher growth rate than females due to the testosterone effect. In partridges, high levels of testosterone were found in females (Bruneli et. al, 2006) and this sex exhibits higher growth rate and mature weight.

Table 2 summarizes the genetic analysis performed for the Gompertz growth curves parameters a and k .

Table 2. Estimates of heritability (h^2), genetic correlation (r_A) and genetic and environmental (co) variances components for the Gompertz growth curve parameters a and k using partridges (*Rhynchotus rufescens*) records.

Growth curve parameters	Variance Component		Covariance Component		h^2 or r_A
	Additive	Environmental	Additive	Environmental	
A	2234.8665	7999.9666			0.22
K	0.00000263	0.00002			0.12
a and k			-0.0460	-0.1855	-0.60

The heritability estimates of the parameters a (asymptotic weigh) and k (rate of maturing) of Gompertz growth curve were 0.22 and 0.12, respectively (Table 2). These results are lower than those found in literature. Braccini Neto et al. (1997) verified heritability estimates for a based on paternal, maternal and paternal and maternal components equals to 0.52, 0.29 and 0.40, respectively. For k , Grossman et al. (1985) reported heritability equal to 0.25 for Rhode Island Red and 0.62 for White Leghorn birds. The results achieved in this research show low heritability estimates for mature weight (a) and average daily gain (k). Despite this, some genetic gain through selection could be achieved for both traits.

The genetic correlation estimates between a and k was -0.60 (Table 2), similar to the one reported by Lopes & Quaas (1997) for layer chickens (-0.59). Therefore, these values indicated that selection could be applied to change the shape of the growth curve and also, selection to improve growth rate would result in light adult birds.

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