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Comparison of Growth Characteristics of Chukar Partridges *(Alectoris chukar)* Raised in Captivity

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Abstract

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This study was carried out to estimate growth curve of chukar partridges and to compare the parameter estimates based on Gompertz, Bertalanffy and Logistic models. The growth curve functions were fitted to the observed data individually by using non-linear regression procedure with Marquart algorithm of SAS, NLIN procedure. Gompertz model (with highest determination coefficient and the lowest residual variance) was found to be the best to determine the growth pattern. Sex had significant effect on the estimates of parameter A and weight and age at inflection point within each model.

Keywords: Growth curve, Gompertz model, Bertalanffy model, Logistic model, chukar partridge.

Introduction

Chukar partridge (*Alectoris chukar*) is widely distributed in Turkey, the Mediterranean islands, Iran and east through Russia and China and south into Pakistan and Nepal. The numbers of wild chukar partridges in Turkey have considerably decreased in the recent years (Çetin *et al.*, 1997) because of an increase in the use of farm machinery and technology, loss of habitat, increase in the number of predators, general use of herbicides and insecticides and excessive hunting (Robles *et al.*, 2001; Gaudioso *et al.*, 2002). Because of the decrease in wild partridge population, the number of game farms that breed birds has increased (Gaudioso *et al.*, 2002). Chukar partridge is a versatile breed in captivity and most adaptable to commercial production. The domestication of partridges and the posterior selection of this species on growth traits could offer an excellent source of protein to human diet (Queiroz *et al.*, 2004).

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The knowledge of the growth curve of partridges would be a very useful tool for setting the first step to breeding programs (Queiroz *et al.*, 2004). Although the growth curve models of a number of diverse avian species have been investigated, limited information is available on growth characteristics of partridges. The aim of the present study was to investigate the growth pattern of chukar partridges and to compare the suitability of logistic, Gompertz and von Bertalanffy growth curve models.

Materials and Methods

This study was carried out in the poultry-breeding unit at the Department of Animal Science, Akdeniz University, Turkey. A total of 236 (120 females and 116 males) chukar partridges were reared following standard management practices. Hatch weights were determined on all birds. Body weights were recorded each week.

Data set of individual body weights of chukar partridges was analyzed using growth curve models (Gompertz, Logistic, Bertalanffy) previously described by Ricklefs (1967). Growth curve models are given below:

Gompertz : $Y_t = A\exp(-B.\exp(-K.t))$

$t_{I=} \ln(B)/K$ $Y_{I=} A/e$

Bertalanffy: $Y_t = A(1-B.\exp(-K.t))^3$

$t_I=(\ln B+\ln 3)/K$ $Y_{I=}8.A/27$

Logistic : $Y_t = A(1+B.\exp(-K.t))^{-1}$

$t_{I=}-\ln(1/B)/K$ $Y_{I=} A/2$

In the models, Y_t is the body weight (g) of birds at t week (t=0,1,..,23). A is an asymptotic weight when time goes to infinity. B is a scaling parameter (constant of integration), which is related to initial values of Y and K is the relative growth rate. Y_I and t_I are weight and age at the inflection point. The Marquardt method was applied to estimate parameters of Gompertz, Bertalanffy and Logistic models by using NLIN procedure in SAS statistical software (SAS, 1999). Final estimates of parameters were obtained when the iterative procedure reaches the convergence criteria 1.0E-05 for all parameters. Differences among sexes for Gompertz, Bertalanffy and Logistic model parameters were tested using PROC MIXED procedure (SAS, 1999).

Results and Discussion

The growth curves of both sexes of chukar partridges appeared very similar to general sigmoid shape of typical growth curve. Maximal growth rate of male and female partridges mainly occurred from hatch to 16 weeks of age and declined thereafter (Fig. 1). The growth patterns of both sexes were different ($P<0.05$); therefore, data set was analyzed separately for each sex. Despite Gompertz equation having the highest determination coefficient and the lowest residual variance in both males and females (Table 1), there are slight differences among the growth functions. This means that growth curves of male and female chukar partridges were adequately described by using the growth functions. The deviations between observed and predicted values for male and female chukar partridges based on the models were very small. Comparing the models in terms of residual sum of squares and determination coefficient, it was found that Gompertz equation was preferable to Bertalanffy and Logistic models. In addition, the correlation coefficients between the observed body weights and the estimated body weights based on Gompertz, Bertalanffy and Logistic equations (0.99974, 0.99942 and 0.99825 for males and 0.99967, 0.99932 and 0.99822 for females, respectively) indicated Gompertz growth curve equation as a better fit model through growth period. Similar results in South American partridges (*Rhynchotus rufescens*) were reported by Queiroz *et al.* (2004).

Differences between male and female for the asymptotic weight estimates (Table 1, parameter A) within all models were significant ($P<0.01$). These results were similar

Table 1
Estimates of growth curve parameters in chukar partridges

	N	A	B	K	R^2
			Gompertz model parameters		
Total	236	501.3±1.3761	4.2030±0.0564	0.2334±0.00221	0.9885
Male	116	543.8±1.4915[a]	4.2399±0.0558	0.2307±0.00215	0.9945
Female	120	460.2±1.2591[b]	4.1656±0.0570	0.2367±0.00228	0.9939
			Bertalanffy model parameters		
Total	236	513.3±1.6517	0.9193±0.0101	0.1920±0.00199	0.9883
Male	116	557.4±1.8151[a]	0.9241±0.0100	0.1893±0.00195[c]	0.9943
Female	120	470.8±1.5151[b]	0.9145±0.0103	0.1952±0.00207[d]	0.9937
			Logistic model parameters		
Total	236	481.9±1.0565	16.9180±0.3966	0.3652±0.00323	0.9877
Male	116	522.1±1.1750[a]	17.2372±0.4097	0.3620±0.00324	0.9937
Female	120	443.1±0.9997[b]	16.6023±0.4066	0.3692±0.00342	0.9932

a and b superscripts show significant difference between sex means for A value, c and d superscripts show significant difference between sex means for K value.

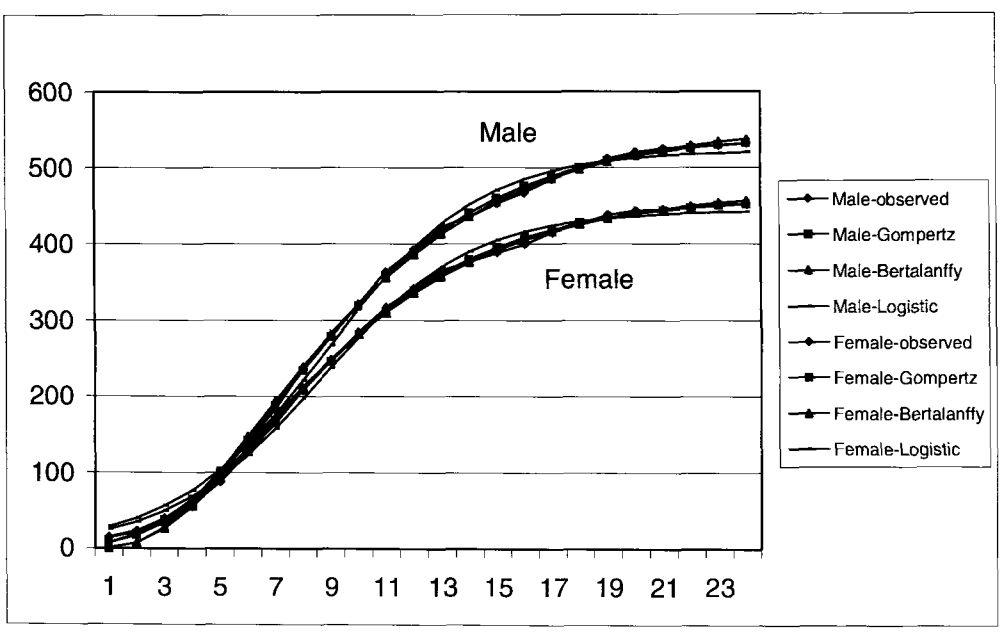


Fig. 1. Observed and predicted growth curves for male and female chukar partridges.

to other galliforms except quails (Akbaş and Yaylak, 2000; Kızılkaya *et al.*, 2004). Sex effect was not significant (P>0.05) for parameter B in all growth models. High K parameter indicates early maturity and smaller mature weights. Akbaş and Yaylak (2000) and Kızılkaya *et al.* (2004) reported a negative correlation between parameters A and K for Japanese quails. As seen in Table 1, significant effect of sex was determined for the estimates of K for Bertalanffy model (P<0.05). Although the parameter K estimates were slightly

Table 2
Estimates of age and weight at inflection point (POI)

	Age at POI	Weight at POI
Gompertz model		
Male	44.0193±0.3893[a]	200.3145±1.1757[c]
Female	42.5827±0.3828[b]	169.9772±1.1560[d]
Total	43.2889±0.2764	184.8888±1.2866
Bertalanffy model		
Male	37.9348±0.3671[a]	165.4597±1.0305[c]
Female	36.6331±0.3609[b]	140.2541±1.0131[d]
Total	37.2729±0.2603	152.6433±1.0933
Logistic model		
Male	55.1407±0.4220[a]	261.3291±1.4413[c]
Female	53.5232±0.4149[b]	222.2350±1.4170[d]
Total	54.3183±0.2999	241.4507±1.6255

a and b superscripts show significant difference between sex means for age at POI, c and d superscripts show significant difference between sex means for weight at POI.

smaller in males than females for Gompertz and Logistic methods, they did not show significant differences between male and female chukar partridges (P>0.05).

Significant sex differences (Table 2) were found between age and body weight at POI (P<0.05). Weight at POI and mature weight of males were higher than for females. Results in this study showed that males reached the POI later than females within Gompertz, Bertalanffy and Logistic models. Du Preez and Sales (1997) reported that this delay is likely to arise from the greater asymptotic value and consequently the longer acceleration phases in the growth curves

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एम. सोनेर बाल्सीयोग्लु, के. कीजिलकाया, के. काराबैग, एस. अल्कान, एच. इब्राहिम योल्कु, ई. साहिन। बंदी दशा में पालित चुकर तीतर (अलेक्टोरिस चुकर) के वर्धन गुणों की तुलना।

चुकर तीतर का वर्धन वक्र आंकलन और गोम्पर्टज्, बर्टालफ्फी एवं तार्किक माडलों के प्राचल आंकलनों के तुलनात्मक अध्ययन के लिए प्रयोग किया गया। मार्कवार्ट एसओएस एल्गोरीद्म, एनएलआईएन संग अरेखी समाश्रयण विधि से वर्धन वक्र क्रियाओं को ज्ञात किए गये आंकड़ों के साथ व्यक्तिगत आसंजित किया गया। वर्धन प्रतिमान जानने के लिए गोम्पर्टज् माडल (सर्वाधिक निर्धारित गुणांक और न्यूनतम अवशेष विविधता के साथ) सर्वोतम पाया गया। प्रत्येक माडल के नतिपरिवर्तन बिन्दु पर प्राचल ए के आंकलन भार और आयु पर लिंग का सार्थक प्रभाव था।