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Full Length Research Paper

Some body measurements and their correlations with live weight in the rock partridge (*Alectoris graeca*)

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The study was carried out to determine some body measurements of male and female rock partridges of varying age (hatching-14 weeks), and to demonstrate the correlations between these measurements and live weight. Body measurements increased with advancing age. The differences between live weights were significant at 6 and 14th weeks (P<0.05 to 0.01). Shank length and shank width (at the *os tarsometatarsus*) were found to be greater in males between the 8 and 14th weeks of age (P<0.01). Differences between the two sexes in length of head were significant at 4 and 14th weeks (P<0.05 to 0.01). As of the second week, a high significant correlation (0.366 to 0.751) was determined among all body measurements and live weight (P<0.001). The most decisive body measurements used in the determination of live weight were shank width, head length and shank length. The lowest prediction (R^2 12.5%) was determined during the hatching period. However, the highest prediction (R^2 = 81.4%) was determined in the 4th week, and generally prediction increased with advancing age (P<0.001). Some body measurements of male and female rock partridges of varying age and the correlation of these measurements with live weight were determined in the study. This study concludes that some body measurements, which can be easily obtained, can be used in the prediction of live weight and as criteria in selection for live weight.

Key words: Partridge, body measurements, live weight, correlation, regression.

INTRODUCTION

Growth and development are physiological features, which bear both practical and economic significance for animal husbandry. Growth occurs under the influence of genetic and environmental factors. Growth is characterized by the increase in body weight, whilst development is characterized by alterations in the structure and shape of the body, its tissues and organs and their functions (Akçapinar and Özbeyaz, 1999). In avian species, the effect of sex on growth becomes more pronounced with advancing age (Akçapinar and Özbeyaz, 1999). Latshaw and Bishop (2001) developed models for the prediction of body composition and live weight of chickens using various body measurements. Çetin et al. (1997a) reported that in pheasants, which belong to the same family with partridges, during the first three weeks of life, body weight gain is quite slow, and that the highest live weight increase is observed during the 5 and 6th weeks. The live weights of Chukar partridges at hatching and at the 4, 8, 12 and 14th weeks were reported as 13.74, 58.21, 161.25, 272.36 and 330.40 g, respectively (Çetin et al., 1997b). In another study, the live weights of rock partridges at the time of hatching and at the 4, 8 and 12th weeks of age were 13.14, 132.52, 329.40 and 425.50 g, respectively (Çetin, 2000). In the same study, the live weights of 10-week-old female and male partridges were 371.43 and 427.69 g, respectively, whilst these values were 409.33 and 474.00 g, respectively in the 12th week.

Deeb and Lamont (2002) are reported that, in avian species, shank length is of a high degree of heritability, and therefore, it can be used as a selection criterion in broilers. Similarly, shank length has also been reported to have effect on live weight in Japanese quails (Dikmen and Đpek, 2006). Furthermore, it has been indicated that carcass components can be predicted with precision, based on body measurements, in Japanese quails (Raji et al., 2009a). In their study with native Korean fowl, Nishida et al. (1983) reported that shank length and

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certain other body measurements were greater in males, in comparison to females. In various avian species, including chickens, geese and ducks, significant correlations were reported to exist between live weight and body measurements (Yang et al., 2006; Saatci, 2008; Raji et al., 2009b). However, the number of relevant studies available for partridges is rather limited.

The present study was aimed at the determination of certain body measurements in male and female rock partridges of varying age, and to demonstrate the correlations between these measurements and live weight.

MATERIALS AND METHODS

Animals and husbandry

This study was conducted at the Research and Practice Farm of Selçuk University Faculty of Veterinary Medicine, Konya, Turkey. A total of forty-one female and 31 male rock partridges (*Alectoris graeca*) were used for the study. Day-old chicks were identified with wing numbers, and sexing was performed as from 8 weeks of age by the trained research team. The chicks were grown in a five-floored cage for three weeks. Subsequently, 72 partridges were placed into 4 cages, sized 1.5 x 1.5 m, such that between weeks 3 to 14 the area provided per partridge was 600 to 1200 cm^2. The birds were provided with a starter diet (28% CP and 2850 MJ/kg ME) during the first five weeks, and in the subsequent period, they were fed a diet containing 22% CP and 2850 MJ/kg ME (Çetin and Kirikçi, 2000). Feed and fresh drinking water were provided *ad libitum*.

Determination of body measurements

The partridges were weighed and their body measurements were taken on a weekly basis during the first 4 weeks post-hatching, and at two week-intervals as from the 4th week post-hatching. The animals were weighed using an electronic scale with a sensitivity of 0.01 g, and measurements were made using a digital calliper with a sensitivity of 0.001 mm. In this study, shank measurements belong to the right side and body measurements were determined as per the procedures of Dursun (2002):

Shank length

The distance between the proximal and distal ends of the os tarsometatarsus.

Shank width

Width at the distal of the metatarsal spur on the os tarsometatarsus.

Shank depth

Depth at the distal of the metatarsal spur on the os tarsometatarsus.

Head width

Distance between the two *pars* orbitalis ossis frontalis.

Head length

Distance between the pars nasalis ossis frontalis and the mid-point of the os occipitale".

Statistical analyses

Differences between the two sexes in live weight and body measurements were determined using the t- test. The correlations between live weight and body measurements were ascertained by means of correlation and regression analyses. Statistical analyses were performed using the SPSS 15.0 (2006) software.

RESULTS AND DISCUSSION

The body measurements of male and female partridges of varying age are presented in Table 1. Body measurements increased with advancing age. The live weights of males and females were 15.08 versus 14.88 g, respectively, at hatching, and 435.99 versus 372.51 g, respectively at the 14th week. The differences between live weights were significant between the 6 and 14th weeks of age ($P<0.05$ to 0.01). The hatching weights obtained in the present study were similar to the values (14.51 and 15.07 g) reported by Çağlayan et al. (2009), and were higher than 13.74 g reported by Çetin et al. (1997b), Çetin (2000) (13.14 g) and Arslan (2003) (12.6 g). The live weights of female and male partridges determined at the 10th week in the present study were lower than the values reported by Çetin (2000) (371.43 and 427.69 g) and Arslan (2003) (330.5 g), and were similar to the value reported by Esen et al. (2006) (313.44 g). Furthermore, the live weights determined in this study on the 12th week were lower than the values reported by Çetin (2000) (409.33 and 474.00 g) and Esen et al. (2006) (382.35 g). In male and female partridges, the shank length varies between 14.95 to 38.24 and 14.60 to 36.49 mm, respectively, from hatching to the 14th week post-hatching. Shank length was higher in males as from the 8th week ($P<0.01$). However, no significant change was observed in any of the sexes as from the 10th week. This finding is in agreement with the report of Woodard et al. (1986), which indicated that the growth of the shank is completed 99% in both male and female Chukar partridges by the 10th week. Furthermore, shank length was reported to be greater in males by Deeb and Lamont (2002) in chickens on the 8th week and by Lukaszewicz et al. (2008) in geese on the 17th week ($P<0.01$; $P<0.05$). Moreover, Saatci and Tilki (2007) ascertained that in native geese (domestic species), differences in shank length, which were in favour of male animals, were observed at the 14 and 16th weeks ($P<0.05$).

From hatching to the 14th week post-hatching, shank width in male and female partridges ranged between 2.34 to 7.10 and 2.30 to 6.51 mm, respectively. From 8 weeks to 14 weeks shank width was greater in males ($P<0.01$). Similarly, Nishida et al. (1983) reported that, in native Korean fowl, the shank width of male animals was greater

Table 1. Body measurements (mm) of male and female partridges of varying age ($\bar{X} \pm S_{\bar{X}}$).

		Weeks									
Body measurements	**Sex**	**Hatching**	**1**	**2**	**3**	**4**	**6**	**8**	**10**	**12**	**14**
LW (g)	Male	15.08±0.17	21.33±0.35	35.76±0.81	52.39±1.29	85.25±2.14	162.66±3.62	250.77±4.52	313.80±5.35	354.55±8.02	435.99±6.22
	Female	14.88±0.16	20.78±0.34	34.71±0.77	49.77±1.28	81.54±2.27	151.06±3.88	223.43±5.04	267.95±5.94	297.68±5.98	372.51±5.53
		NS	NS	NS	NS	NS	*	**	**	**	**
SL	Male	14.95±0.10	17.66±0.13	20.37±0.16	22.77±0.21	26.12±0.30	31.87±0.33	37.78±0.41	38.90±0.35	39.25±0.34	38.24±0.31
	Female	14.60±0.10	17.55±0.11	20.18±0.23	22.80±0.26	25.78±0.29	31.16±0.36	35.87±0.31	36.65±0.27	36.97±0.25	36.49±0.24
		*	NS	NS	NS	NS	NS	**	**	**	**
SW	Male	2.34±0.03	2.68±0.03	3.13±0.06	3.65±0.04	4.65±0.05	5.39±0.05	6.17±0.05	6.53±0.06	6.83±0.05	7.10±0.07
	Female	2.30±0.03	2.58±0.03	3.09±0.04	3.55±0.05	4.48±0.06	5.26±0.06	5.79±0.05	6.10±0.05	6.47±0.06	6.51±0.05
		NS	*	NS	NS	*	NS	**	**	**	**
SD	Male	1.95±0.04	2.11±0.02	2.49±0.03	2.94±0.03	3.53±0.04	4.16±0.04	4.50±0.05	4.75±0.05	4.95±0.05	5.16±0.06
	Female	1.88±0.02	2.37±0.31	2.36±0.02	2.80±0.03	3.33±0.03	3.94±0.04	4.22±0.03	4.42±0.03	4.60±0.03	4.81±0.04
		NS	NS	**	**	**	**	**	**	**	**
HW	Male	12.90±0.09	13.06±0.11	13.46±0.14	14.60±0.14	15.36±0.14	17.32±0.19	19.64±0.17	21.13±0.14	21.89±0.18	22.45±0.25
	Female	12.58±0.08	12.71±0.10	13.55±0.13	14.35±0.15	15.09±0.12	17.03±0.17	18.90±0.14	20.34±0.11	21.24±0.14	21.03±0.15
		**	*	NS	NS	NS	NS	**	**	**	**
HL	Male	16.10±0.12	18.48±0.11	19.52±0.18	21.60±0.16	24.88±0.23	30.58±0.25	33.02±0.31	34.72±0.28	36.19±0.31	37.81±0.31
	Female	15.86±0.14	18.11±0.10	19.58±0.16	21.41±0.17	24.24±0.22	29.82±0.24	31.90±0.23	33.68±0.24	34.48±0.21	35.93±0.24
		NS	*	NS	NS	*	*	**	**	**	**

LW: Liveweight, SL: Shank length, SW: Shank width, SD: Shank depth, HW: Head width, HL: Head length. NS: Not significant, *: P<0.05, **: P<0.01.

than that of females. Contrary to this study, Saatci and Tilki (2007) suggested that in native geese, sex did not have any influence on shank width. In the present study, between the 2nd and 14th weeks, shank depth ranged between 2.49 to 5.16 versus 2.36 to 4.81 mm in male and female partridges, respectively, which demonstrated that the difference between sexes was significant (P<0.01). In compliance with the results of the present study, Lukaszewicz et al. (2008) ascertained that, in geese, shank depth was greater in male animals at the 17th week (P<0.05). In the present study, the head widths of male and female animals were 19.64 versus 18.90 mm, respectively, on the 8th week, and as 22.45 versus 21.03 mm, respectively, on the 14th week (P<0.01). Differences between the two sexes for head width were significant in the periods between hatching and the 1st week post-hatching and weeks 8 to 14 (P<0.05; P<0.01).

On the other hand, Saatci and Tilki (2007) reported that, in geese, the two sexes did not differ for head width between weeks 2 to 8, while head width was greater in males between weeks 10 to 16 (P<0.05; P<0.01). In the present study, the head length of male and female partridges ranged between 16.10 to 37.81 versus 15.86 to 35.93 mm, respectively, in the period from hatching to the

Table 2. Correlation matrix between live weight and some body measurements in rock partridges.

Age (weeks)	LW (g)	SL (mm)	SW (mm)	SD (mm)	HW (mm)	HL (mm)
Hatching	14.96	0.301*	0.193	0.097	0.120	0.016
1	21.02	0.495***	0.337**	-0.101	0.062	0.192
2	35.16	0.677***	0.622***	0.751***	0.366**	0.495***
3	50.90	0.721***	0.787***	0.698***	0.527***	0.644***
4	83.14	0.715***	0.817***	0.570***	0.528***	0.708***
6	156.06	0.765***	0.722***	0.463***	0.595***	0.638***
8	235.21	0.708***	0.763***	0.363**	0.643***	0.747***
10	287.69	0.580***	0.688***	0.349**	0.590***	0.553***
12	322.17	0.625***	0.595***	0.495***	0.490***	0.557***
14	399.84	0.580***	0.832***	0.627***	0.554***	0.656***

LW: Liveweight, SL: Shank length, SW: Shank width, SD: Shank depth, HW: Head width, HL: Head length. *: P<0.05, **: P<0.01, ***: P<0.001.

Table 3. Some Regression equations for live weight prediction in rock partridges*.

Age (weeks)	Constant (a)	SL (x_1)	SW (x_2)	SD (x_3)	HW (x_4)	HL (x_5)	R^2 (%)
Hatching	6.94	0.49	0.71	0.61	-0.01	-0.12	12.5
1	-11.74	1.39	3.41	-0.14	-0.22	0.13	34.4
2	-39.42	1.30	3.16	12.36	0.75	-0.08	73.2
3	-75.96	0.94	10.87	6.99	0.91	1.55	73.5
4	-141.83	1.83	17.31	4.22	1.77	2.34	81.4
6	-260.11	4.23	17.08	2.70	4.05	3.71	75.4
8	-364.49	0.48	42.10	2.48	4.26	7.37	75.9
10	-543.24	1.97	44.60	0.47	13.76	5.56	62.1
12	-613.10	6.27	35.72	4.30	10.46	6.11	56.1
14	-370.26	2.04	63.59	-3.78	2.07	6.48	76.2

SL: shank length, SW: shank width, SD: shank depth, HW: head width, HL: head length. *: $Y=a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5$.

14th week post-hatching. However, difference between males and females for head length were significant between the 4 and 14th weeks (P<0.05 to 0.01). This contradicts the results to the resultsof the present study, Saatci and Tilki (2007) reported that, in native geese, head length was not significantly affected by sex. Correlation coefficients between live weights and body measurements are presented in Table 2. Accordingly, it can be seen that correlation coefficients ranged from 0.016 to 0.832. The highest correlation coefficient (0.832) was between live weight and shank width, whilst the lowest correlation coefficient (0.016) was between live weight and head length. In the hatching period, only the correlation coefficient between live weight and shank length (P<0.05), and in the 1st week post-hatching the correlation coefficient between shank length and shank width showed significant differences.

As from the 2nd week post-hatching, a positive and high significant correlation was between all body measurements and live weight (P<0.01; P<0.001). Similarly, a positive and significant correlation was obtained between live weight and body measurements by Gueye et al. (1998) and Yang et al. (2006) in chickens, by Raji et al. (2009b) in Muscovy ducks, and by Saatci and Tilki (2007) in native geese (P<0.01). Furthermore, a significant correlation was reported between body length and live weight by Petek et al. (2008) in broiler chickens and quails and by Saatci (2008) in geese (P<0.05; P<0.01). Regression equations between live weight and body measurements ($Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5$) are shown in Table 3. The most decisive body measurements used in the prediction of live weight are shank width, head length and shank length. The lowest prediction (R^2 = 12.5%) was obtained during the hatching period. On the other hand, the highest prediction (R^2 = 81.4%) was obtained in the 4th week and in general, prediction increased with advancing age of the birds (P<0.001). Similarly, models based on the use of body measurements for the prediction of live weight were developed by Latshaw and Bishop (2001) in chickens, by Saatci and Tilki (2007) and Lukaszewicz et al. (2008) in geese, and by Raji et al. (2009b) in Muscovy ducks.

In conclusion, in the present study, certain body measurements of male and female rock partridges of varying age and the significant correlations between these body measurements and live weight were obtained. Some body measurements, which can be easily obtained, can be used in the prediction of live weight and as criteria in selection for improved live weight.

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