

Divergent selection for four-week body weight in Japanese quail (*Coturnix coturnix japonica*): response to selection and realized heritability

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Abstract The Japanese quail has been utilized as a research species in establishing the genetic relationships that may also be present in other species. Divergent phenotypic selection for 4-wk BW was conducted for three generations in high (HW) and low (LW) lines. Within each line, 50 females and 25 males were selected among 600 birds, based on 4-wk BW. Mean BW at 4 wk of age in the base generation was 186.2 and 178.6 g for females and males, respectively. In the 3rd generation, the mean of 4-wk BW for male and female birds was 214.5 and 208.1 in HW line and 173.5 and 167.8 in LW lines, respectively. The realized heritability was estimated as 33.4% and 28.3% for females and males in HW lines and 20.3% and 20.2% for females and males in LW lines. The results suggested the effectiveness of phenotypic selection for body weight in Japanese quails, although the hatchability decreased in the heavier birds.

Keywords: divergent selection, realized heritability, Japanese quail

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Introduction

The Japanese quail is a useful experimental animal because it is small, reaches puberty at an early age, has a high breeding efficiency and can easily be raised (Ri et al., 2005). Published estimates of heritability for body weight and growth rates in Japanese quail, from 2 wk of age through sexual maturity, averaged 0.40 in an unselected control population and in a population undergoing only short term selection for body weight (Marks, 1991). The realized heritability of body weight decreased with selection, being more rapid when selection was practiced for decreased than for increased BW (Moritsu et al., 1997). Selection for BW also resulted in decreased hatchability and egg production and increased age at sexual maturity (Darden and Marks, 1988). The main purpose of this study was to produce quail lines with high efficiency, and to determine the realized heritability, response to selection, effect of divergent selection on variance and correlated response to selection on fitness traits.

Materials and methods

Animals

A divergent selection for body weight at 4 wk of age was performed during three generations, and three lines were established. Among 600 birds in a base population, 25 males and 50 females with higher and lo-

wer BW at 4 wk were selected as the High (HW) and Low (LW) body weight individuals, respectively. Similarly, 25 males and 50 females were selected randomly as the control group. In each of the first three generations, the required birds were obtained from five hatches. In the HW line, the birds with higher weights and in the LW line, the birds with lower weights at four weeks of age were selected as the parents for the next generation with no selection being practiced among the control birds.

Management

The hatching eggs were collected for two weeks after mating. The eggs collected during each week were transferred into a setter maintained at 37.7 °C and 70% humidity. The hatched chicks were raised inside a brooder until four weeks of age and the selected pairs (50 females and 25 males) were then transferred to the mating cages. The brooder temperature was kept at 37° C during the first couple of days after hatching, 34° C until the end of the first week, 30°C during the second week, 27° C during the third week, and between 20 to 30° C subsequently. The lighting duration was 24 h during the first week of age which was reduced to 23 h from the second to fourth weeks of age. In the laying house, the lightening regimen was set at 16 h light and

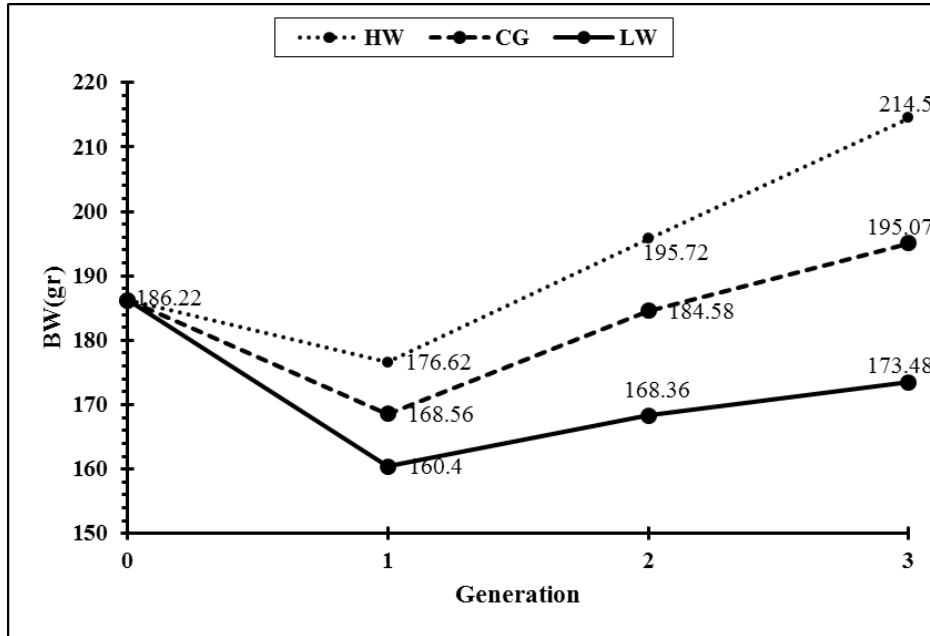


Figure 1. Response to selection for 4-wk body weight in female Japanese quails in 3 generations for high weight (HW), low weight (LW), and control (CG) birds.

8 h dark. The diet contained 26% crude protein and 2900 kcal/kg metabolizable energy until the fourth week of age. Feed and water were available *ad libitum*.

Data analysis

The realized h^2 at 4-wk BW was obtained by dividing the cumulative response (R) by cumulative selection differential (CSD) in the HW and LW lines, with control values being used to correct for the environmen-

tal variations across generations. In generation 3, the hatchability was calculated as the ratio of hatched chicks to the number of eggs incubated. Data were analyzed using the general linear model (GLM) procedure (SAS, 2000) according to the following model:

$$Y_{ijkl} = \mu + L_i + S_j + H_k + e_{ijkl} \quad (1)$$

where, μ is the common mean, L_i is the effect of the i^{th} line, S_j is the effect of j^{th} sex, H_k is the effect of k^{th} hatch,

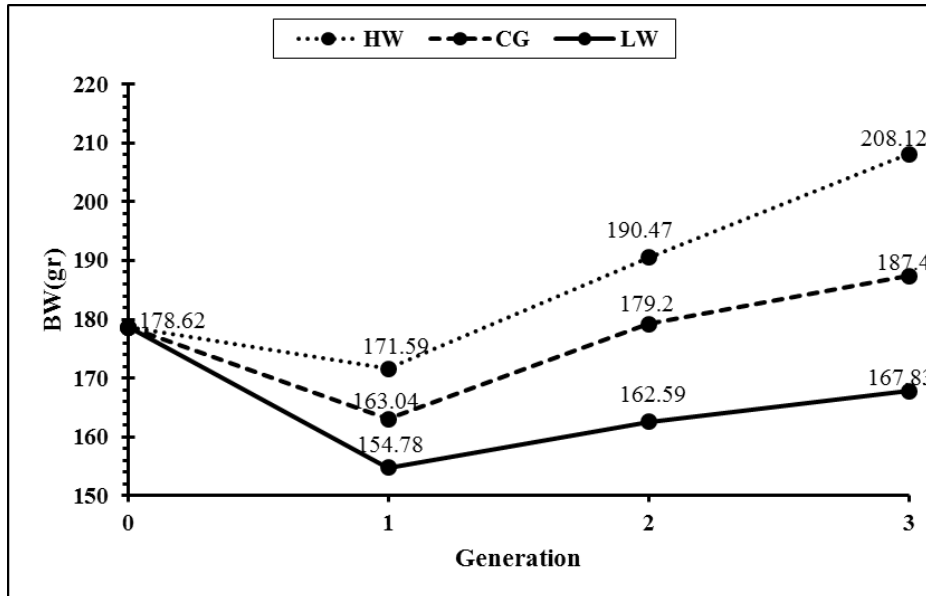


Figure 2. Response to selection for 4-wk body weight in male Japanese quails in 3 generations for high weight (HW), low weight (LW), and control (CG) birds.

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and e_{ijkl} is the residual error. Mean separation was performed according to Duncan (1955).

Results and discussion

Response to selection

The response to divergent selection for 4-wk body weight is presented in Figures 1 and 2 for females and males, respectively. The HW line was significantly ($P < 0.0001$) larger than LW line in all generations.

Selection response was similar for the HW and LW lines in the first generation, but in the third generation it was greater in the HW than in LW line. These findings are in agreement with the results of other researchers (Marks, 1991; Anthony et al., 1996). In general, females were larger than males, and the effect of sex was significant in all lines and generations. Unlike the present results, Marks (1996) reported that there was an absence of BW differences between sexes at four weeks of age in the L line. The interaction effect of line by sex was not significant at four weeks of age.

Realized heritability

Selection differential (SD) for the HW line was larger than for LW line. Larger SD in HW line was associated with the expression of greater overall variance in 4-wk BW in HW line. The realized heritability for 4-wk BW (Table 1) was within the range of values reported by other researchers (Marks, 1991; Anthony et al., 1996; Moritsu et al., 1997). The estimated heritabilities in the L line were lower than in the H line (Table 1), in agreement with Anthony et al. (1996) and Saatci et al. (2006).

The average body weight of females at five weeks of age in the third generation for HW, control and LW lines were 260.3, 241.0 and 222.2 g, respectively ($P < 0.0001$). In the third generation, the hatchability in HW, control and LW lines were 0.51 ± 0.02 , 0.56 ± 0.02 and 0.63 ± 0.02 , respectively ($P < 0.01$). The data showed that selection for increasing body weight at 4 wk of age resulted in reduced hatchability.

Table 1. Cumulative selection differential (CSD), cumulative response (R) to selection and realized heritability of 4-wk body weight in Japanese quails in three generations.

Line	Sex	CSD (gram)	R (gram)	h^2
HW	Female	77.98	26.04	0.3340
	Male	89.91	25.52	0.2838
LW	Female	-73.72	-14.98	0.2030
	Male	-73.25	-14.77	0.2020

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