DIRECT AND CORRELATED RESPONSE TO THE INDEX WITH CONSTRAINT IN SELECTION FOR BODY WEIGHT AND FEED CONVERSION RATIO ON JAPANESE QUAIL

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SUMMARY

Paper presents the results of selection on index with constraint (in which body weight at the 28th day would be improved and feed conversion ratio between 14-21 days - kept constant) after 5 generation in contrast to the effects of selection for body weight alone. The index selection slightly modified the growth pattern. Feed conversion the index line after a few generations tended towards the value obtained in body weight line.

INTRODUCTION

There were several selection experiments on poultry in which, besides of body weight or gain, feed consumption and/or efficiency were involved. Selection for each of these traits was effective and accompanied by correlated responses of the remaining ones. Some of them (Wilson 1969, Guill and Washburn 1974, Pym 1982) indicated a considerable, and independent of growth traits, variation in feed consumption or efficiency. According to Marks's summarized results (1991) the greatest differences in growth rate, feed intake and conversion ratio between lines of chicken and quail selected for 4th week body weight occured during the first weeks of life.

The present work attempted to model the growth pattern by selection for body weight at a fixed age in which feed intake is forced, but in proportion to body weight gain during the juvenile growth. It was assumed that it might be accomplished using an index with constraint in which two traits would be included: a) body weight at a fixed age - the one to be improved; b) feed conversion ratio - the one to be kept constant.

The earlier papers (Michalska 1993 a,b) presented the estimation of genetic parameters and the index construction. This paper presents direct and correlated responses after 5 generation of selection.

MATERIAL AND METHODS

Selection experiment.

Birds for selection originated from population of Japanese quail maintained during 10 generations after 4-lines diallel crossing. At that time population consisted of 48 randomly mated pairs. From the 10th (base) generation three lines of 16 pairs in each of them were formed:

1) I - line selected on the index value: $I=BW_{28}+11.16 \cdot FCR_{14-21}$ where BW_{28} means body weight at the 28th day of age, FCR_{14-21} - feed conversion ratio for 14-21 days period;
2) M - line selected for increasing body weight at the age of 28 day;
3) C - control line.

In the selected lines a model of within-family selection was applied. Matings within lines were done using a computer programme in which a minimum average of inbreeding of hypothetical progeny determined a combination of mated pairs.

The birds were kept in a battery system with 14/10 light/dark cycle and fed ad libitum a commercial diet containing 26% crude protein.

In each generation the following traits were measured:

- body weight at the 14th, 21st and 28th day of age (BW_{14}, BW_{21}, BW_{28}),
- individual feed consumption for the periods of 14-21 and 21-28 days (FC_{14-21}, FC_{21-28}).

Data were submitted to the least squares means analysis in which line, hatch and sex effects were estimated then the data were additively adjusted for the two latter effects. Using the adjusted data body weight gains (WG_{14-21}, WG_{21-28}, WG_{14-28}) and feed conversion ratio (FCR_{14-21}, FCR_{21-28}, FCR_{14-28}) were calculated. Adjusted data served for selection purpose as well as for the further analysis.

Effects of selection.

In each generation selection differentials weighted by an offspring number per standard phenotypic deviations were calculated. The analogous calculations were made for the correlated traits on the base of the weighted adventage of the chosen parents on the generation mean. Then the average intensities for all twelve traits and index units after 5 generations were counted.

The genetic changes of all traits in the three lines were expressed as the regression coefficients of the trait mean value on generation number. In case of selected lines mean traits values were given as the deviations from the control line.

Realized heritabilities for the index units and body weight at the 28th day were determined as the regression of cumulative weighed selection differentials on cumulative selection responses (both based on deviations from control line).

Realized genetic regression coefficients were calculated as the regression of the cumulative correlated response of trait Y on cumulative direct response of index or body weight (X) ($b_{YX}=CR_Y/Re_X$) after the 3rd and the 5th generation. Predicted values of regression coefficient were estimated as: $b'_{YX}=r_G(h_Y\sigma_{PY}/h_X\sigma_{PX})$, where genetic parameters estimated in the base population and standard phenotypic deviations from the base generation were used.

RESULTS

Mean number of tested birds per generation, mean inbreeding coefficients in the 5th generation (including pedigree of ten generations of the base population), number of birds tested as well as average values of the principal traits and index units in the 5th generation for each line presents table 1.

Table 1. Mean number of birds per generation (n), mean inbreeding coefficients (F), number of birds (n') and mean values (x) of principal traits in the 5th generation.

Line / Item	I x	I sd	M x	M sd	C x	C sd
n	156.8	-	161.2	-	156.2	-
F	.0685	.0012	.0715	.0014	.0698	.0011
n'	144	-	173	-	153	-
BW_{28} (g)	124.3 A[1)]	8.4	124.6 B	8.7	111.6 AB	8.7
FCR_{14-21}	3.22 A	.47	3.20 B	.49	3.40 AB	.51
Index	158.03 A	7.62	158.20 B	7.94	147.27 AB	7.16

1) the means with the same letter differ significantly at $P\leq.01$.

As the inbreeding coefficient was very similar in all lines, its influence on the selection results has not been considered.

Body weight, feed conversion and index in the both selected lines were significantly different in comparison to the control line. The differences between selected lines were very small and insignificant in any case.

Table 2 shows mean selection intensities for selected lines as well as the regression of 12 traits mean values and the index units on generation number in three lines. The obtained intensities were in general in a good agreement with the predictions. It was assumed that line M would gain more and would be more efficient. The contradiction of both selected lines, also according to the assumptions, occured for weeks body gains and conversion ratio. Regression coefficients in the control line were insignificant for any trait. Genetic changes in both selected lines were significant for almost all growth traits (with the exception of BW_{14}), feed intake and index units. In M line conversion ratio lowered in the expected direction (insignificant for FCR_{21-28} only). Reaction of feed conversion in I line was not significant, but the sign of regressions was quite contrary to the expectations. Also, the index values were unexpectedly similar in both selected lines.

Table 2. Mean selection intensities (i) and regression coefficients (b±se) of the trait means on generation number

Line / Trait	I (i)	M (i)	I (b ± se)	M (b ± se)	C (b ± se)
BW_{14}	.66	.55	.71 ± .28	.62 ± .25	.88 ± .52
BW_{21}	.54	.65	1.70 ± .48*	1.65 ± .36**	.94 ± .54
BW_{28}	.74	.74	2.23 ± .45**	2.36 ± .26**	1.21 ± .57
FC_{14-21}	.66	.43	2.46 ± .41**	2.19 ± .36**	.24 ± .53
FC_{21-28}	.55	.45	2.89 ± .43**	2.89 ± .24**	.73 ±1.79
WG_{14-21}	.22	.50	.99 ± .24**	1.03 ± .17**	.06 ± .57
WG_{21-28}	.47	.31	.53 ± .14**	.72 ± .10**	.27 ± .16
FCR_{14-21}	.36	-.23	-.02 ± .02	-.03 ± .01*	-.00 ± .07
FCR_{21-28}	-.03	-.04	.02 ± .02	-.01 ± .02	-.02 ± .05
WG_{14-28}	.50	.59	1.52 ± .19**	1.75 ± .13**	.32 ± .53
FC_{14-28}	.70	.50	5.35 ± .66**	5.09 ± .35**	.96 ±2.27
FCR_{14-28}	.22	-.17	-.01 ± .01	-.02 ± .01*	-.01 ± .06
Index	.95	.65	2.00 ± .31**	2.03 ± .18**	1.05 ± .96

** - significant at P≤.01
 * - significant at P≤.05

Realized heritabilities after 5 generations were: 0.25±0.03 for index and 0.38±0.04 for body weight at the 28th day. The values of these parameters, previously estimated, were 0.28±0.03 and 0.46±0.04 respectively.

Table 3 presents realized genetic regressions of correlated on direct responses after the 3rd and 5th generation in contrast to predicted values for both selected lines and all traits. Regression coefficients for the 3rd generation were almost all insignificant, undoubtedly because of only one degree of freedom. In four cases the significant regressions coefficients of determination (R^2) were equal 1. At the 5th generation, determination for none of the traits reached 1. The common result for both generations and lines was that higher correlated responses of body weight at the 28th day (or index), body weight gains (particularly in the fourth week) and specially of feed intake were obtained in comparison to the expected ones.

It seems that genetic correlation between feed consumption and body weight were underestimated or they changed very quickly independently of selection criterion. Reaction in feed intake during a given week simply follows the changes of body weight measured at the beginning of this week, altough the estimated correlation of these two traits (for example 0.59 for BW_{14} and $FC_{14\text{-}21}$) were only little higher than the correlation between BW_{14} and $WG_{14\text{-}21}$ (r_G=0.51) or $WG_{14\text{-}21}$ - $FC_{14\text{-}21}$ (r_G=0.51).

Table 3. Predicted regression coefficients (A) and realized genetic regressions (b±se) of cumulative response of correlated trait on cumulative direct response of the selected trait after 3rd (B) and 5th (C) generation.

Line	I	M	I	M	I	M
Trait	A		B		C	
BW_{14}	.49	.41	.46 ± .17	.23 ± .40	.30 ± .13	.20 ± .11
BW_{21}	.84	.86	.86 ± .18	.67 ± .30	.82 ± .22**	.67 ± .11**
BW_{28}	.96	-	1.11 ± .29	-	1.15 ± .15**	-
FC_{14-21}	.78	.53	1.03 ± .26	.81 ± .32	1.20 ± .20**	.94 ± .10**
FC_{21-28}	.62	.52	1.53 ± .02**	1.16 ± .43	1.46 ± .28**	1.16 ± .32*
WG_{14-21}	.30	.42	.39 ± .01*	.43 ± .10	.52 ± .15*	.47 ± .07**
WG_{21-28}	.14	.16	.25 ± .11	.33 ± .30	.33 ± .13	.33 ± .11
FCR_{14-21}	.00	-.02	-.01 ± .03	-.02 ± .00	-.01 ± .01	-.02 ± .01
FCR_{21-28}	.00	-.00	.01 ± .01	-.02 ± .03	-.00 ± .01	-.01 ± .01
WG_{14-28}	.41	.52	.65 ± .12	.77 ± .40	.85 ± .11**	.80 ± .11**
FC_{14-28}	1.40	1.04	2.56 ± .24	1.98 ± .11*	2.67 ± .16**	2.10 ± .28**
FCR_{14-28}	.00	-.01	-.00 ± .02	-.02 ± .01	-.01 ± .01	-.01 ± .00*
Index	-	.62	-	.80 ± .03*	-	.83 ± .05**

** - significant at P≤.01

* - significant at P≤.05

Correlated response to selection in M line was lower than predicted in case of body weight at the 14th and 21st day, almost the same for $WG_{14\text{-}21}$ and higher for feed intake, gain between 21-28 day and index value. Correlated changes of feed conversion, though significant in period of 14-28 days after the 5th generation only, follow the sign and values of the predicted regressions.

In I line there was a good agreement between the expected and realized parameters for body weight at the 14th and 21st day. There was an advantage of realized over predicted regressions for body weight at the 28th day, feed intake and gain in the 14-21 days period and much more pronounced advantage for feed intake and gain in the following week. Conversion ratio was insignificant in any case, but in light of intensities and predicted values as well as the reaction of M line this was not the index selection effect. Comparison of realized genetic regressions between the 3rd and 5th generation shows tendency of line I approaching line M.

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