# GENETIC AND PHENOTYPIC CORRELATIONS FOR ASCITES RELATED TRAITS IN BROILERS

**A. Pakdel[1], J.A.M. Van Arendonk[1], A.L.J. Vereijken[2] and H. Bovenhuis[1]**

[1] Animal Breeding and Genetics Group, WIAS, P.O. Box 338, 6700 AH, Wageningen, The Netherlands
[2]Nutreco Breeding Research Center, P.O. Box 220, 5830 AE, Boxmeer, The Netherlands

## INTRODUCTION

Ascites, also known as water belly, is a growth-related disorder of broilers that occurs more often in fast growing birds and at low temperatures. This syndrome has been a source of concern to the poultry industry for the last decades. It has been estimated that ascites accounts for losses of about US $ 1 billion annually around the world (Maxwell and Robertson, 1997). For developing selection strategies to reduce ascites, the genetic parameters such as heritability and genetic correlations among ascites related traits should be known.
Several studies reported moderate to high heritabilities for ascites related traits (Lubritz *et al*., 1995 ; De Greef *et al*., 2001 ; Moghadam *et al*., 2001 ; Pakdel *et al*., 2002). This offers perspectives for selection against this syndrome. Only few studies reported genetic correlations among ascites related traits. Moghadam *et al*. (2001) reported a positive genetic correlation between ascites and body weight where traits were measured under normal climatic conditions. However, under cold conditions, De Greef *et al*. (2001) reported a negative genetic correlation between ascites and body weight.
The objective of this study was to estimate genetic and phenotypic correlations for ascites related traits under cold conditions.

## MATERIAL AND METHODS

**Animals.** Ascites related traits were recorded on 4 202 broilers originating from a cross between two White Plymouth Rock lines. The total pedigree file consisted of 5 096 animals of which 36 were pure line animals ($F_0$), 29 were $F_1$ animals, 829 were $F_2$ animals and 4 202 were $F_3$ animals. Observations were on $F_3$ animals. A more detailed description of the experimental set up is given by Van Kaam *et al*. (1998).
The experimental animals hatched during six different weeks in 1994 and 1995. Animals were kept in 4 different pens, however, the majority of animals were kept in one of the pens. Depending on the hatching day and the pen number, 9 different batches were defined. In order to identify individuals that were susceptible to ascites, an alternative (cold-stressed) temperature schedule was applied. At the time of hatching, temperature was 30 degrees Celsius and then gradually decreased to 10 degrees Celsius at an age of 22 days. The temperature remained 10°C until the end of the experiment. Except for the adjusted temperature schedule, birds were kept under circumstances that closely resemble commercial practice, i.e. a standard commercial feed, artificially lighted housing for 23 hours per day, and group housing with 20 birds per square meter.
**Traits.** The body weight (BW) and hematocrit value (HCT) of animals were measured one day before slaughtering at 5 weeks of age. After slaughtering, a number of ascites related traits

were measured. The weight of the right ventricular (RV) and the total ventricular weight (TV) were measured. From these measurements the ratio of right ventricular weight to the total ventricular weight (RATIO) was derived. Further, the accumulation of fluid in the abdomen (ABD) was scored as 0, 1 or 2. A score of 0 indicated no fluid (3 542 individuals), 1 indicated the presence of fluid in the abdomen (23 individuals) and 2 indicated a serious accumulation of fluid in this section (132 individuals). Also the total mortality (MOR) of the birds was recorded and scored as 0 or 1. A score of 0 represented that the birds were alive at the end of the experiment (2 095 individuals) and a score of 1 indicated that the bird died before the end of the experiment (399 individuals). For the first three batches of birds, mortality was not recorded. Birds that died before the end of experiment have no observation for other traits.

**Genetic Analysis.** An animal model was used to calculate heritabilities and genetic correlations of ascites related traits ;

$$Y_{ijklm} = \mu + Sex_i + Feather_j + Batch_k + Group_l + a_m + e_{ijklm}$$

where : $Y_{ijklm}$ = the dependent variable on chicken m of sex i, feathering class j from batch k in group l ; $Sex_i$ = fixed effect of sex i (i = 1, 2 female / male) ; $Feather_j$ = fixed effect of feathering j (j = 1, 2 fast /slow) ; $Batch_k$ = fixed effect of batch k of the birds (k = 1, 2…9), with classes based on a combination of hatching day and pen ; $Group_l$ = Fixed effect of group (l = 1, 2…46), with classes based on the age of dam and the hatching day of the experimental animals ; $a_m$= random direct genetic effect of individual m ; $e_{ijklm}$ = random residual effect. The fixed and random effects in this model were identical for all the traits studied. Bivariate analyses were performed to compute correlations between all combinations of traits. Estimates of variance components were obtained using the ASREML software (Gilmour *et al*., 2000).

## RESULTS AND DISCUSSION

Means and standard deviations for the traits measured under cold conditions are presented in table 1. The average weight of broilers at 5 weeks was 1 604 g and the total mortality in this experiment was 16 %. Under normal conditions mean values were 28.3 % ($\pm$ 2.3) for HCT, 1.15 g. ($\pm$ 0.30) for RV, 5.60 g ($\pm$ 0.94) for TV, and 20.64 % ($\pm$ 4.66) for RATIO (Pakdel *et al*., 2002).

**Table 1. Statistical description of traits measured under cold conditions**

| Trait | Abbreviation | Number | Mean | SD |
|---|---|---|---|---|
| Body weight at 5 weeks (g). | BW | 3693 | 1604 | 263 |
| Hematocrit value (%) | HCT | 3547 | 35.40 | 4.21 |
| Right ventricular weight (g). | RV | 3660 | 1.95 | 0.68 |
| Total ventricular weight (g). | TV | 3658 | 6.97 | 1.17 |
| Ratio of RV to TV (%) | RATIO | 3658 | 27.94 | 8.07 |
| Total mortality[1] | MOR | 2494 | 0.16 | 0.37 |
| Fluid in the abdomen[2] | ABD | 3697 | 0.08 | 0.38 |

[1]Score trait with 0 or 1 ; [2] Score trait with 0, 1 or 2

The estimated genetic and phenotypic correlations between ascites related traits are presented in table 2. With a few exceptions, genetic correlations reported in table 2 were all positive. BW had negative genetic correlations with HCT (-0.23) and RATIO (-0.27). These estimates

suggest that, under the applied experimental conditions (cold stress), the heavier broilers have lower HCT values and a lower RATIO. However, the positive genetic correlation between BW and TV (0.58) indicates that heavier birds have a larger total ventricular weight.
At first sight, the correlations between BW and ascites-indicator traits like HCT and RATIO might seem unexpected as research generally showed that higher productivity in broiler leads to higher $O_2$ requirements and consequently results in an increased incidence of the ascites syndrome (e.g. Julian, 1993 ; Summers, 1994, Moghadam *et al*., 2001). Therefore, one might expect heavier birds to have higher HCT values and higher RATIO's, corresponding to a higher incidence of ascites. Apparently, under the present experimental conditions these relationships are influenced by the susceptibility of birds against ascites : birds can only achieve a high body weight in case they show some resistance against ascites.
The above results are generally in agreement with results previously obtained by De Greef *et al*. (2001). They estimated a negative $r_g$ between 5-wk body weight and ascites candidate traits, e.g. -0.54 with HCT and –0.26 with RATIO. However, in the unaffected subpopulation, De Greef *et al* .(2001) estimated a positive $r_g$ between BW and RATIO (0.29). Therefore, it was concluded that genetic correlation between productivity and ascites is sensitive to the disease status of the birds, which complicates selection.
Ascites is defined as accumulation of fluid in the abdominal cavity and therefore is best described by the trait ABD. The genetic correlation between ABD and MOR was highly positive (0.96). In the present experiment MOR was defined as the total mortality but apparently mortality was mainly due to ascites. The high genetic correlation between ABD and RATIO (0.82) suggests that RATIO is a good indicator for ascites. Lubritz *et al*. (1995) estimated genetic correlations between ABD and RATIO in broilers exposed to cold temperatures varying from 0.46 to 0.78, depending on the broiler line and the growth rate.

**Table 2. Estimates of genetic parameters of ascites related traits[A]**

| Trait | BW | HCT | RV | TV | RATIO | MOR | ABD |
|---|---|---|---|---|---|---|---|
| BW | **0.42±0.01** | -0.23±0.10 | 0.06±0.10 | 0.58±0.06 | -0.27±0.09 | -0.06±0.14 | 0.00±0.17 |
| HCT | -0.37±0.02 | **0.46±0.05** | 0.54±0.07 | 0.20±0.10 | 0.56±0.07 | 0.72±0.08 | 0.66±0.12 |
| RV | 0.06±0.02 | 0.40±0.02 | **0.47±0.05** | 0.60±0.07 | 0.89±0.02 | 0.43±0.11 | 0.74±0.09 |
| TV | 0.63±0.01 | -0.03±0.02 | 0.49±0.02 | **0.46±0.05** | 0.15±0.10 | -0.25±0.12 | 0.22±0.16 |
| RATIO | -0.30±0.02 | 0.50±0.02 | 0.86±0.01 | 0.01±0.02 | **0.45±0.05** | 0.62±0.10 | 0.82±0.07 |
| MOR | 0.42±0.03 | 0.34±0.03 | 0.04±0.03 | -0.11±0.03 | 0.11±0.03 | **0.32±0.06** | 0.96±0.03 |
| ABD | -0.33±0.02 | 0.29±0.02 | 0.29±0.02 | -0.15±0.02 | 0.46±0.02 | 0.57±0.02 | **0.08±0.03** |

[A] Heritabilities (± s.e.) on the diagonal, Phenotypic correlations below and genetic correlations above the diagonal. Heritabilities obtained in univariate analysis, but genetic and phenotypic correlations obtained in bivariate analysis.

The standard errors of estimated genetic correlations were high for bivariate analyses where one or both of the traits were score traits. Heritability estimates obtained from the univariate analyses (table 2) were in general consistent with estimates from bivariate analyses. However, for bivariate analyses that comprise mortality, deviating heritability estimates were obtained, e.g. for BW (0.32) and ABD (0.21). Reason for this might be that birds that died during the experiment do not have observations for these traits.

This study reports genetic and phenotypic correlations among ascites related traits. These correlations provide valuable information that can be used to characterize the ascites syndrome. Further, these correlations are required for developing selection strategies to reduce the incidence of this disorder. Correlations where estimated under circumstances that induce ascites. De Greef *et al*. (2001) indicated that estimated correlations are different for affected and unaffected birds. Therefore, correlations between traits measured under normal and cold conditions should be subject of future research. Further, Pakdel *et al*. (2002) indicated that some of the ascites related traits are significantly affected by maternal genetic effects, which were not taken into account in the models used in this study. Additional studies need to provide information on the effect of including maternal genetic effects on the estimated genetic correlations between traits.

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